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ACTIVE DISTURBANCE REJECTION COLLISION AVOIDANCE COMPLIANT CONTROL BASED ON PASSIVITY THEORY OF SPACE ROBOT WITH COMPLIANT MECHANISM CAPTURE SPACECRAFT

Abstract

In recent years, with the development of space technology and the further development of human space exploration, the on-orbit servicing and maintenance of space robots has become an important development direction in the field of aerospace. In order to achieve on-orbit servicing tasks, the ability of space robots to capture the target spacecraft is an indispensable key technology. Considering that when the space robot performs the capture operation task, it is inevitable to contact and collide with the target spacecraft. In this process, the joint of the space robot will be subjected to a large collision impact torque. If the impact torque is too large, it may cause damage to the joints. For the reason, the collision avoidance compliant control for free-floating space robot on-orbit capture non-cooperative spacecraft is studied. A compliant mechanism, Rotary Series Elastic Actuator (RSEA) is mounted between the joint motor and manipulator, its function are: First, the deformation of its internal spring can absorb the impact energy of the captured spacecraft on the joints of the space robot; Second, the joint impact torque can be limited to a safe range by combining with the collision avoidance compliant control scheme. First of all, the dynamic models of the space robot and the target spacecraft before capture are obtained by using the Lagrange approach and Newton-Euler method. After that, based on the law of conservation of momentum, the constraints of kinematics and the law of force transfer, the integrated dynamic model of the combined system is derived. Finally, considering the post-capture unstable motion which is caused by the impact effect, a passivity-based active disturbance rejection compliant control is proposed for post-capture combined system. The combined with a compliant mechanism control scheme proposed above can not only effectively absorb the impact energy generated by the on-orbit capture, but also timely open and close the joint motor when the impact energy is too large, which can avoid overload and damage of the joint motor. In addition, the control scheme uses the extended state observer to realize the dynamic estimation of the disturbance, and combine with passivity theory to compensate it, which can improve disturbance rejection ability by the impact effect of capture effectively. Numerical simulation verified the effectiveness of the proposed control scheme.