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COLLISION STUDY OF SPACE DEBRIS CAPTURE BY SERVICE SPACECRAFT WITH ROBOTIC ARMS CONNECTED BY FLEXIBLE JOINTS

Abstract

The use of space robots to capture space debris is one of the current research hotspots. There are still non-negligible errors in the velocity, position and attitude of space debris identified by the target, and collisions will inevitably occur during the capture operation.A conventional rigid manipulator with a matching size is used for the capture task,and the space manipulator with service spacecraft will hit from a large, additional momentum to change its position, speed, causing a further instability in the event of a collision, even big collision force will cause damage to spacecraft and space debris, the task to catch space debris brought great difficulties.PAMs are light in weight, good in flexibility, large in output force/torque, and have excellent characteristics similar to human muscle.The flexible antagonistic joint driven by PAMS has a small stiffness and a small impact force when it contacts with the target debris, so the impact force of the whole space service system is correspondingly small.Complex kinetic friction between the braided sleeve can cause energy loss, which leads to the joint damping are bigger, the low frequency and large vibration generated after the collision will decay and disappear in a short time, it reduces the impact on the system dynamic characteristics,eliminate the necessity of vibration suppression, to save fuel.In conclusion, the rigid manipulator connected by flexible antagonistic joints can capture space debris more stably.The space service system consists of a homogeneous cube base, seven homogeneous rigid connecting rods and an end-effector connected by flexible antagonistic joints.Tondu and Lopez model can well predict the relationship between tension, length and internal pressure of the PAMs, and it also considers the internal friction effect of the PAMs.By using this model we can derive the flexible antagonism joint model, and analyze the characteristics of stiffness and damping model compared with the traditional joints. Then based on the second Lagrange function equation,establish a dynamic model of service space systems.Finally, based on the collision force model of Hertz contact theory, establish the collision dynamics model of the whole system in the process of target captured.Set the specific parameters of the space service system,and evaluate advantages and disadvantages of the flexible antagonistic joints according to the simulation results.