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STRUCTURAL TOPOLOGY OPTIMIZATION FOR A LIGHT SIX-DOF SPACE ROBOTIC MANIPULATOR

Abstract

In this paper, a light-weight study on a 6-dof space manipulator is carried out. Space robotic manipulator is one of the indispensable tools for carrying out manned spaceflight, deep space exploration, in-orbit service and space debris removal. It undertakes key tasks such as space debris removal, transferring, acquisition and control of enemy spacecraft. The mass ratio of the arm rod of space robotic manipulator is the largest, which has a great influence on the positioning accuracy of the manipulator end. In order to give consideration to the requirement of higher static dynamic characteristics and lower self - weight of space robotic manipulator, topology optimization based on variable density method is proposed. The mathematical model is constructed by using the mathematical method of relative difference for improving the stiffness and the natural frequency of each order. The design of static and dynamic multi-objective topological optimization of the arm rod for the light robotic manipulator is carried out to obtain the arm rod structure. The results of the analysis indicate that the mechanical arm rod is designed as light weight structure, while the stiffness and the low order of dynamic natural frequency of each working condition are not significantly reduced. The application of relative difference method effectively avoids the problem of optimizing the result of the order of magnitude in the process of multi-objective optimization. The optimization results show that this method could be applied to the design and optimization of other light space roboticmanipulator parts.