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COLLISION-FREE PATH PLANNING OF SPACE ROBOT FOR MULTIPLE TASKS

Abstract

Currently, space robots are widely used for on-orbit service, such as testing, measuring or cleaning the space environment. Besides, with an increasing number of debris appear in the space, it is of great meaning to capture several of them successively for saving energy. In this paper, the collision-free path planning problem of space robot for multiple tasks is studied. The robot, with seven revolute joints, is in free-floating mode. Besides, it is required to finish multiple common or different tasks. Common tasks are testing several places or capturing several space debris continuously. Different tasks include testing, measuring and spot welding. However, some irregular obstacles are in the path of finishing the tasks. The position and orientation of the obstacles and tasks are given, while the sequence of the tasks is unknown in the problem. Besides, the regions of the tasks are points, circles or rectangles. The space robot should bypass the obstacles and finish the given tasks with optimum distance and with minimum attitude disturbance to the base of the space robot. The collision-free path planning problem of free-floating space robot for multiple tasks is solved as follows. Firstly, the Ant Colony Optimization algorithm ("ACO" for short) is used to find the optimal tasks sequence, without considering the obstacles. Besides, a comparison of ACO with other algorithms is presented to show the efficiency of ACO. Secondly, the optimal collision-free path between adjacent tasks with minimum distance is given, in which the irregular obstacles are surrounded by cubes with optimum sizes respectively. Besides, an optimization algorithm is introduced to find the optimum cube for any irregular obstacle. Thirdly, the joints movements are presented with minimum attitude disturbance to the base, utilizing the kinematic equations of free-floating space robot. Furthermore, simulation results are presented to show effectiveness and efficiency of the method.