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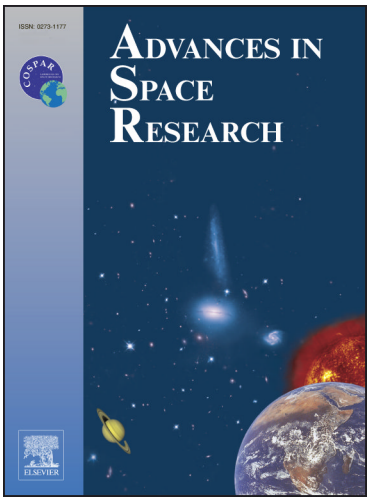

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Optimal Trajectory Planning of Free-Floating Space Manipulator Using Differential Evolution Algorithm

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Abstract

The existence of the path dependent dynamic singularities limits the volume of available workspace of free-floating space robot and induces enormous joint velocities when such singularities are met. In order to overcome this demerit, this paper presents an optimal joint trajectory planning method using forward kinematics equations of free-floating space robot, while joint motion laws are delineated with application of the concept of reaction null-space. Bézier curve, in conjunction with the null-space column vectors, are applied to describe the joint trajectories. Considering the forward kinematics equations of the free-floating space robot, the trajectory planning issue is consequently transferred to an optimization issue while the control points to construct the Bézier curve are the design variables. A constrained differential evolution (DE) scheme with premature handling strategy is implemented to find the optimal solution of the design variables while specific objectives and imposed constraints are satisfied. Differ from traditional methods, we synthesize null-space and specialized curve to provide a novel viewpoint for trajectory planning of free-floating space robot. Simulation results are presented for trajectory planning of 7 degree-of-freedom (DOF) kinematically redundant manipulator mounted on a free-floating spacecraft and demonstrate the feasibility and effectiveness of the proposed method.

Keywords: trajectory planning, free-floating, reaction null-space, Bézier

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