航空学报
ACTA AERONAUTICA ET ASTRONAUTICA SINICA
ISSN 1000-6893
CN 11-1929/V

航空学报 » 2012, Vol. 33 » Issue (8) :1531-1539 DOI:

基于速度增量的空间绳系机器人中距离逼近过程最优轨迹规划

徐秀栋, 黄攀峰, 孟中杰, 王东科

西北工业大学 航天飞行动力学技术重点实验室, 陕西 西安 710072

Space Tethered Robot Optimal Trajectory Planning for Medium Approaching Range Based on Velocity Impulse

XU Xiudong, HUANG Panfeng, MENG Zhongjie, WANG Dongke

National Key Laboratory of Aerospace Flight Dynamics, Northwestern Polytechnical University, Xi’an 710072, China

摘要 针对空间绳系机器人中距离逼近过程最优轨迹规划问题,提出了基于速度增量的多目标逼近轨迹优化方法,优化指标为总速度增量及逼近时间。首先建立逼近过程相对动力学模型及最优逼近轨迹优化模型,然后利用改进型非劣分类遗传算法得到相对逼近距离1.5 km内逼近轨迹的Pareto最优解。仿真结果表明,该方法可以揭示空间绳系机器人逼近距离1.5 km内逼近时间、燃料消耗、相对目标的面内视界角及速度增量次数之间的相互关系,能满足针对不同任务需求提供相应最优轨迹的要求。

关键词： 空间绳系机器人 速度增量 轨迹规划 遗传算法 Pareto最优解

Abstract： This paper proposes a multi-objective trajectory optimization approach based on velocity impulse for the medium range trajectory planning of a space tethered robot, The optimization includes total velocity impulse and flight time. First, a relative dynamic model and a trajectory optimization model are provided for an approaching target of the space tethered robot. Next, the non-dominated sorting genetic algorithm is employed to obtain the optimal trajectory Pareto solution set for a relative distance of 1.5 km. Simulation results show that this method can reveal the relationships among flight time, fuel consumption, planar view angle and velocity impulse number. By identifying multiple solutions, the approach can produce the corresponding optimal trajectory to meet different task requirements for a medium approaching range.

Keywords： space tethered robot velocity impulse trajectory planning genetic algorithms Pareto optimal solutions

Received 2011-10-25;

Fund:国家自然科学基金(60805034, 61005062);西北工业大学博士论文创新基金(CX201217);航天飞行动力学技术重点实验室开放基金(2012afdl022)

Corresponding Authors: 黄攀峰 Email: pfhuang@nwpu.edu.cn

引用本文:

徐秀栋, 黄攀峰, 孟中杰, 王东科. 基于速度增量的空间绳系机器人中距离逼近过程最优轨迹规划[J]. 航空学报, 2012, 33(8): 1531-1539.

XU Xiudong, HUANG Panfeng, MENG Zhongjie, WANG Dongke. Space Tethered Robot Optimal Trajectory Planning for Medium Approaching Range Based on Velocity Impulse[J]. Acta Aeronautica et Astronautica Sinica, 2012, 33(8): 1531-1539.