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流体力学与飞行力学

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<< << 前一篇 | 后一篇 >> >>

低速风洞动态试验的高速并联机构设计及动力学分析

谢志江¹, 孙小勇¹, 孙海生², 张钧^{1,2}

1. 重庆大学 机械传动国家重点实验室, 重庆 400044;
2. 中国空气动力研究与发展中心, 四川 绵阳 621000

Mechanism Design and Dynamics Analysis of High Speed Parallel Robot for Dynamic Test in Low Speed Wind Tunnel

XIE Zhijiang¹, SUN Xiaoyong¹, SUN Haisheng², ZHANG Jun^{1,2}

1. National Key Laboratory of Mechanical Transmission, Chongqing University, Chongqing 400044, China;
2. China Aerodynamics Research and Development Center, Mianyang 621000, China

摘要

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摘要

为模拟飞行器多自由度(DOF)风洞试验,设计并制造了一种用于低速风洞试验的高速并联六自由度机构,综合分析需求和机构的约束条件,确定机构的结构参数,并分析和总结了该机构的特点。使用ANSYS软件计算系统的固有频率,得到系统极限位置的振动响应。利用ADAMS软件对机构进行柔性动力学仿真,模拟机构在高速运动时紧急制动的动力特征,比较分析刚性和柔性制动的冲击载荷,总结出机构高速制动的特点,所分析结果在机构的设计和实际应用中具有重要的意义。实际运行表明:并联机构可实现单自由度和多自由度耦合运动,具有大工作空间(振幅可达30° /500 mm)、高运动精度(达0.05° /0.5 mm)和高速(达5 m/s)等特点,并具有较高的运动性能,满足风洞试验要求。

关键词: 并联机构 高速 柔性动力学 风洞试验 运动规划 六自由度

Abstract:

In order to simulate the multiple degrees of freedom (DOF) wind tunnel test of an aircraft, a high speed 6-DOF parallel mechanism for low speed wind tunnel tests is designed. The structural parameters of the mechanism are given by a comprehensive analysis of its requirements and restrictions. The characteristics of the parallel mechanism are analyzed. The vibration responses at the limit positions of the system are calculated by ANSYS software. At the same time, a flexible dynamic simulation for high speed emergency braking is analyzed by ADAMS tool; the characteristics of high speed braking are summarized based on a comparative analysis of the rigid and flexible brake loads. The simulation results prove that this study is important for the design of the prototype of a parallel mechanism and its application. The experiment shows that the parallel mechanism can fulfill both single degree and multi degree oscillatory motions; it also has a large work space (up to 30° /500 mm), high motion accuracy (up to 0.05° /0.5 mm) and high speed (up to 5 m/s). In conclusion, the high speed 6-DOF parallel mechanism has high motion capability to meet the wind tunnel test requirements.

Keywords: parallel mechanism high speed flexible dynamic wind tunnel test motion planning six degrees of freedom

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