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一种用于机载设备的高精度转动型柔性铰链

刘承平[1,2], 赵宏哲[2], 毕树生[2]

1. 中国电子科学研究院, 北京 100041;
2. 北京航空航天大学 机械工程及自动化学院, 北京 100191

A Precise Rotational Flexure Pivot for Airborne Equipment

LIU Chengping[1,2], ZHAO Hongzhe[2], BI Shusheng[2]

1. China Academy of Electronics and Information Technology, Beijing 100041, China;
2. School of Mechanical Engineering and Automation, Beihang University, Beijing 100191, China

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摘要

传统铰链应用于机载设备时会产生摩擦、磨损、接触面热梯度等问题,而利用材料变形产生运动的柔性铰链可避免此类缺陷,获得高性能的同时,降低维护成本。现阶段使用的交叉簧片柔性铰链无法满足某些超精密航空机载设备的定位精度要求,因此将交叉点推广到任意位置以改善性能。首先,考虑机械接口,建立了广义交叉簧片柔性铰链的刚度和轴漂模型,从而分析了各个参数与刚度及轴漂的关系,并评估了由于加工因素造成的簧片不等长给性能带来的影响,得到了具有等值刚度和较小轴漂特性的柔性铰链。然后,通过有限元仿真验证了所分析特性的有效性。最后,通过组合提出了一种更大行程的复合柔性铰链,当转角为15° 时,且在垂直力作用下,轴漂小于3 μm,精度优于在国外已得到应用的蝶形铰链。

关键词： 柔性铰链 刚度 轴漂 精密机械 机载设备

Abstract:

Current joints used for airborne equipment suffer from problems of friction, wear, and thermal gradients. Flexure pivots, on the other hand, achieve their motion by the deflection of their flexible members, so the performance increases and the cost reduces. At present, the cross-spring pivot cannot satisfy the positioning requirements for some ultra-precision airborne equipment. Consequently, the intersection point is generalized to arbitrary position in order to improve the performance. Firstly, considering the mechanical interface, a model for the generalized cross-spring pivot is developed. The relationships between stiffness/accuracy and design parameters are analyzed, and the influence is evaluated of two different length leaves resulting from manufacturing errors on its performance. Therefore, a flexure pivot with constant stiffness or small center shift is obtained. Furthermore, the characteristics revealed by the analysis model are verified by finite element analysis (FEA). Finally, taking the advantage of building block method, a complex flexure pivot with higher precision is proposed. When the rotational angle is up to 15° and a vertical load is applied, the center shift of the complex flexure pivot is less than 3 μm, and its precision is even better than the butterfly pivot, which is extensively utilized abroad.

Keywords: flexure pivot stiffness center shift precision machine airborne equipment

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Corresponding Authors: 刘承平,Tel.: 010-68893170 E-mail: liuchengping@foxmail.com Email: liuchengping@foxmail.com

About author: 刘承平 男, 硕士, 工程师。主要研究方向: 飞行器总体设计, 精密仪器。 Tel: 010-68893170 E-mail:

Service
把本文推荐给朋友
加入我的书架
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作者相关文章
刘承平
赵宏哲
毕树生
徐熠

liuchengping@foxmail.com;赵宏哲 男, 博士。主要研究方向: 柔性机构, 精密定位系统。 Tel: 010-82338019 E-mail: hongzhezhao@gmail.com;毕树生 男, 博士, 教授, 博士生导师。主要研究方向: 精密定位系统, 机器人技术。 Tel: 010-82338019 E-mail: bishusheng@gmail.com;徐熠 男, 硕士研究生。主要研究方向: 柔性机构。 Tel: 010-82338019 E-mail: speedwings@gmail.com

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