唐继伟,胡峪,宋笔锋.关键设计参数对摆线桨气动性能影响[J].航空动力学报,2015,30(2):297~305

关键设计参数对摆线桨气动性能影响

Influence of key design parameters on aerodynamics performance of cycloidal propeller

投稿时间：2013-09-16

DOI： 10.13224/j.cnki.jasp.2015.02.006

中文关键词: 气动性能 摆线桨 关键设计参数 非定常 动网格

英文关键词: aerodynamics performance cycloidal propeller key design parameters unsteady dynamic mesh

基金项目:

作者	单位
唐继伟	西北工业大学 航空学院, 西安 710072
胡峪	西北工业大学 航空学院, 西安 710072
宋笔锋	西北工业大学 航空学院, 西安 710072

中文摘要:

以西北工业大学自行研制的摆线桨飞行器为研究对象,对简化的二维摆线桨模型进行了非定常数值模拟.在数值模拟模块中,桨叶的公转及俯仰振荡运动采用弹簧近似光滑模型和局部重划模型相结合的动网格技术来处理.重点研究了关键设计参数对摆线桨气动性能的影响,结果表明:随着桨叶数的增加,悬停气动效率提高;随着翼型厚度增加,推力变大,气动功耗减小;桨叶俯仰轴位置位于桨叶弦向中部位置时的功率载荷最大,悬停气动效率最高;随着最大俯仰角增大,气动功耗逐渐增加,悬停气动效率降低;当桨叶上、下半周最大俯仰角之和一定时,采用上半周最大俯仰角小的设置时,推力和气动功耗较大,悬停气动效率也更高.

英文摘要:

The two-dimensional cycloidal propeller model was simplified from a cycloidal propeller aircraft developed by Northwestern Polytechnical University. The dynamic mesh method of spring-based smoothing and local remeshing was adopted to achieve blades' rotating and pitching movement in the unsteady numerical simulation. The influence of the key design parameters on aerodynamics performance of cycloidal propeller was researched. The result shows that, the aerodynamics efficiency of hovering status is found higher with the increase of blade number; when the airfoil thickness increases, the thrust level is higher while the aerodynamics power is lower; the aerodynamics efficiency of hovering status and power loading reach highest when the pitching axis is located at middle chord length of blade; when the maxium pitching angle is higher, the aerodynamics power becomes larger and aerodynamics efficiency of hovering status is lower; and when the sum of maxium pitching angle at top position and maxium pitching angle at bottom position is constant, the thrust, aerodynamics power and aerodynamics efficiency of hovering status are higher if the maxium pitching angle at top position is small.

参考文献(共18条):

[1] Benedict M,Ramasamy M,Chorpra I.Performance of acycloidal rotor concept for micro-air-vehicle applications[J].Journal of the American Helicopter Society,2010,55(2):1-14.

[2] HU Yu,Lim K B,HU Wenrong.The research on the performance of cyclogyro[R].AIAA-2006-7704,2006.

[3] Siegel S,Seidel J,Cohen K.A cycloidal propeller using dynamic lift[R].AIAA-2007-4232,2007.

[4] Sirohi J,Parsons E,Chopra I.Hover performance of a cycloidal rotor for a micro air vehicle[J].Journal of the American Helicopter Society,2007,52(3):263-279.

[5] Nozaki H,Sekiguchi Y,Matsuuchi K.Research and development on cycloidal propellers for airships[R].AIAA-2009-2850,2009.

[6] Benedict M,Sirohi J,Chopra I.Design and testing of a cycloidal-rotor MAV[C]//Proceedings of the International Specialists\' Meeting on Unmanned Rotorcraft.Chandler,US:Curran Associates,2007:404-410.

[7] Benedict M,Chopra I,Ramasamy M,et al.Experimental investigation of the cycloidal-rotor concept for a hovering micro air vehicle[C]//Proceedings of the 64th Annual Forum of the American Helicopter Society.Montreal,Canada:Curran Associates,2008:2571-2580.

[8] Benedict M,Ramasamy M,Chopra I,et al.Experiments on the optimization of the MAV-scale cycloidal rotor characteristics towards improving their aerodynamic performance[C]//Proceedings of the International Specialists\' Meeting on Unmanned Rotorcraft.Scottsdale,US:Curran Associates,2009:545-546.

[9] Jarugumilli T,Benedict M,Chopra I.Experimental optimization and performance analysis of a MAV scale cycloidal rotor[R].AIAA-2011-821,2011.

[10] Benedict M,Jarugumilli T,Chopra I.Design and development of a hover-capable cyclocopter MAV[C]//Proceedings of the 65th Annual National Froum of the American Helicopter Society.Grapevine,US:Curran Associates,2009:27-29.

[11] Kim S J,Yun C Y,Kim D,et al.Design and performance tests of cycloidal propulsion systems[R].AIAA-2003-1786,2003.

[12] In S H,Seung Y M,Choong H L,et al.Experimental investigation of VTOL UAV cyclocopter with four rotors[R].AIAA-2007-2247,2007.

[13] Mcnabb M L.Development ofa cycloidal propulsion computer model and comparison with experiment[D].Mississippi:Mississippi State University,2001.

[14] 杨茵,李栋,张振辉.微型扑翼飞行器非定常运动对平尾的影响[J].航空学报,2012,33(10):1827-1833. YANG Yin,LI Dong,ZHANG Zhenhui.Influences of flapping wing micro aerial vehicle unsteady motion on horizontal tail[J].Acta Aeronautica et Astronautica Sinica,2012,33(10):1827-1833.(in Chinese)

[15] Jameson A.An assessment of dual-time stepping,time spectral and artificial compressibility based numerical algorithms for unsteady flow with applications to flapping wings[R].AIAA-2009-4273,2009.

[16] 张晓庆,王志东,张振山.二维摆动翼仿生推进水动力性能研究[J].水动力学研究与进展,2006,21(5):632-639. ZHANG Xiaoqing,WANG Zhidong,ZHANG Zhenshan.Hydrodynamic study of bionic propulsion for 2-D flapping foil[J].Journal of Hydrodynamics,2006,21(5):632-639.(in Chinese)

[17] 张强,杨永.绕翼型低雷诺数流动的数值分析研究[J].空气动力学学报,2006,24(4):482-486. ZHANG Qiang,YANG Yong.Numerical analysis of low-Reynolds-number flow over airfoil[J].Acta Aerodynamica Sinica,2006,24(4):482-486.(in Chinese)

[18] Menter F R,Rumsey C.Assessment of two-equation turbulence models for transonic flows[R].AIAA 94-2343,1994.

相似文献(共20条):

[1] 唐继伟,胡峪,宋笔锋,李为吉.基于LB动态失速模型的摆线桨气动性能计算方法[J].飞行力学,2011,29(3).

[2] 徐学忠.摆线泵基本参数的优化设计[J].液压与气动,2003(12):6-7.

[3] 万朝燕 李力行.摆线针轮行星传动的参数优化[J].大连铁道学院学报,1992,13(1):42-47.

[4]

罗东明,昂海松.倾转螺旋桨飞行器桨叶的气动设计研究[J].航空动力学报,2002,17(5):513-517.

[5] 施科益,杨世锡.一种新型摆线推进器控制系统的设计[J].机电工程,2008,25(10).

[6] 张明路,刘冰清,孙立新.基于修形参数的摆线齿轮可靠性优化设计[J].机械设计,1998,15(9):24-25.

[7] 康理茂,许玲滨.基于UG的摆线齿轮参数化设计[J].现代机械,2013(4).

[8] 徐学忠.多齿差摆线齿轮泵基本参数的优化设计[J].机床与液压,2005(3):88-90.

[9] 刘导治.桨扇气动设计问题[J].航空动力学报,1987(4):295-298,367.

[10]徐学忠.摆线泵几何参数选择及齿廓不产生根切的条件[J].机床与液压,2004(12):203-205.

[11]高文坤,殷志宏,张克,陈梦云.一种基于反设计的气动参数估计方法[J].系统仿真学报,2008,20(4):1041-1044,1048.

[12]程秀芹,李永红,王恩怀,翁志能.飞行器气动参数测试系统的设计[J].自动化与仪表,2010,25(10).

[13]古尊礼,熊小艳.摆线马达优化设计研究[J].煤矿机械,2009,30(1).

[14]陈平剑,徐玉貌.旋翼桨叶气动外形设计[J].直升机技术,2007(3):16-19.

[15]卞学良.摆线泵和摆线马达齿形参数优化设计[J].河北工业大学学报,1995(4).

[16]石军辉,李永红,王恩怀.飞行器气动参数测试系统设计[J].传感器与微系统,2015(2):113-115,135.

[17]张胜利,席德科.飞艇螺旋桨气动优化设计[J].机电一体化,2009,15(11):78-81.

[18]徐学忠.异型齿廓摆线泵的参数优化设计[J].流体机械,2005,33(2):20-23.

[19]唐文献,丁浩,张智敏,金翔.摆线针齿马达参数优化及CAD设计[J].装备制造技术,2013(10):14-16.

[20]朱继华,裴帮,侯东海,刘忠明.外啮合摆线类齿轮泵啮合原理及参数设计[J].机械传动,2004,28(1):10-13.