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微动量轮高精度滑模变结构控制

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High precision sliding mode control for micro-momentum wheel

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摘要 图/表 参考文献 相关文章 (15)

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摘要 基于滑模变结构算法研究了小卫星微动量轮的精确控制。在系统整体控制框架的基础上,对微动量轮动力学模型进行了分析;结合理想模型引入纹波电压、摩擦系数不确定性、扰动力矩等干扰因素,完善了微动量轮动力学模型。设计了等效滑模变结构控制算法,并对控制率参数进行了仿真优化。通过MATLAB仿真,对比分析了滑模变结构控制和常规PI控制在转速控制和力矩控制两种模式下的特性。最后,实验设计了微动量轮样机。仿真结果表明:基于滑模变结构控制的微动量轮转速控制精度达到±0.5 r/min,从0加速到2 000 r/min的时间为18 s,均明显优于PI控制。实验结果表明:利用滑模变结构控制的微动量轮转速控制精度达到±0.9 r/min,从0加速到2 000 r/min的时间为26 s。上述结果显示:利用滑模变结构控制算法可以有效克服微动量轮控制中的干扰因素,提高转速控制精度和输出力矩稳定度,缩短转速变化响应时间。

关键词 : 小卫星, 姿态控制, 微动量轮, 滑模控制, 仿真计算, 样机实验

Abstract : The precision control of a micro-momentum wheel in micro-satellite was researched based on a sliding mode control algorithm. On the basis of the whole control system framework, the dynamic model of the micro-momentum wheel was analyzed. Combination of the ideal model and consideration of the interference factors such as ripple voltage, the uncertainty of friction coefficient, and disturbance torque, the dynamic model of micro-momentum wheel was improved. Then, sliding mode control algorithm was designed, and simulation control rate parameters were optimized. Through MATLAB simulation, sliding mode control and conventional PI control were compared for the torque control and speed control. Finally, a micro-momentum wheel prototype was designed. The simulation results show that the speed control precision of the micro-momentum wheel based on sliding mode control is ±0.5 r/min and it can accelerate from 0 to 2 000 r/min in 18 s, both are much better than that based on PI control. Experimental results demonstrate that the speed control precision of the micro-momentum wheel based on sliding mode control is ±0.9 r/min and it can accelerate from 0 to 2 000 r/min in 26 s. These results indicate that sliding mode control algorithm effectively overcomes the control interference factors of the micro-momentum wheel and improves the speed control precision, shortens the acceleration time.

Key words : micro-satellite attitude control micro-momentum wheel sliding mode control simulation and calculation prototype experiment

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