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### 基于泵式流体回路的小卫星姿控/热控一体化执行机构设计

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### Design of a Combined Attitude and Thermal Control System for Small Satellites Based on Mechanically- pumped Fluid Loop

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摘要

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**摘要** 主要研究了小卫星姿控/热控一体化执行机构的设计问题.首先,根据流体回路中液体流速变化对小卫星产生力矩实现姿态控制、液体流动吸/散废热实现热控制的原理,提出一种姿控/热控一体化执行机构设计方案.然后针对该设计方案,利用以电机转速为变量的流体回路内压强和电磁力矩方程,推导了一体化执行机构姿控力矩模型;利用散热量随流体回路流速的变化,建立了一体化执行机构热控模型.最后,针对某小卫星设计了基于姿控/热控一体化执行机构的闭环控制系统,并针对该一体化执行机构设计了一种姿控/热解耦算法,对其姿控/热控能力进行数学仿真验证,仿真结果证明了该一体化执行机构的有效性.

**关键词:** 航天工程 卫星 控制系统综合 姿控/热控一体化系统 泵式流体回路 液体动量控制器 流体控制 齿轮泵

**Abstract:** This paper presents the design study of a combined attitude and thermal control actuator for small satellites. First, a design scheme of an attitude/thermal control actuator is proposed based on the principle that the annular flow in a fluid loop accelerated by mechanical pumps will exert torques on the satellite and absorb waste heat by circulation. Second, the attitude control torque model of this combined actuator is obtained in accordance with this scheme by using the equations derived for the electromagnetic torque and the fluid pressure with the motor speed as the independent variable. The heat model of this combined actuator is also built since heat dissipation changes with the flow rate of the fluid loop. Third, a closed-loop control system of a certain small satellite is designed based on the proposed combined actuator and an algorithm is defined to decouple the attitude and thermal control. Simulations are performed to demonstrate the effectiveness of the combined actuator for both attitude and thermal control.

**Keywords:** space engineering satellite control system synthesis combined attitude and thermal control system mechanically-pumped fluid loop fluidic momentum controller fluid control gear pump

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