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刚体航天器姿态跟踪系统的自适应积分滑模控制

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Adaptive Integral Sliding Mode Control for Rigid Spacecraft Attitude Tracking

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摘要

采用自适应滑模控制(ASMC)技术进行姿态跟踪系统设计时,切换增益的整定不需要外部干扰及惯量阵不确定性的上界信息。但现有自适应滑模控制方法存在过度适应问题,产生的切换增益远大于控制所需值。为解决该问题,在自适应滑模控制框架内开展了刚体航天器姿态跟踪控制研究。首先对切换增益自适应机制进行分析,揭示了造成过度适应问题的原因。然后利用积分滑模控制的全局滑模特点,消除了初始跟踪误差对自适应过程的影响,提出了一种自适应积分滑模姿态跟踪控制方法。理论分析和仿真结果表明该方法能够有效减小切换增益。

关键词： 姿态控制 自适应滑模 过度适应 抖振削弱 积分滑模

Abstract:

When the adaptive sliding mode control (ASMC) technique is utilized for attitude tracking system design, a prior knowledge of the upper bounds of external disturbances and inertia matrix uncertainty is not required for switching gain tuning. However, there may be over-adaptation in current ASMC design in that the generated switching gain is unnecessarily large with respect to the required value. To address such a problem, this paper considers the attitude tracking control of a rigid spacecraft in the framework of ASMC design and proposes an adaptive integral sliding mode control scheme. First, the underlying causes of over-adaptation are analyzed in detail. Then, the influence of initial tracking error on switching gain adaptation is eliminated by exploiting the global sliding mode feature of the integral sliding mode control. The switching gain reduction ability of the proposed strategy is verified by theoretical analysis and simulation results.

Keywords: attitude control adaptive sliding mode over-adaptation chattering suppression integral sliding mode

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