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微纳技术与精密机械

机载光电平台的复合补偿控制方法

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摘要： 为实现机载光电平台的实时高精度稳定跟踪控制,提出了一种基于改进干扰观测器和模糊逼近的复合自适应补偿控制方法。首先,根据系统的机械结构特点分析了各框架间的运动学耦合关系;考虑到载体扰动的影响,提出了一种基于速度信号的改进干扰观测器结构,并分析了它的工作原理和鲁棒稳定性。然后,针对机械系统中普遍存在的摩擦等干扰现象,设计了基于模糊逼近的复合补偿控制策略以保证系统的跟踪性能。最后,利用Lyapunov稳定性理论证明了系统的全局稳定性和跟踪误差的渐进收敛。实验结果显示,该控制方法具有较高的稳定精度,其跟踪误差可达μrad数量级,表明该方法可以有效地抑制载体扰动的影响并且具有良好的跟踪性能,是可行有效的。

关键词： 机载光电平台 视轴稳定跟踪 干扰观测器 模糊系统 复合控制 Lyapunov稳定性

Composite compensation control scheme for airborne opto-electronic platform

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Abstract: A novel composite compensation control scheme based on an improved Disturbance Observer (DOB) and fuzzy approximation was proposed to achieve the real-time stabilization and high-precision tracking control of an airborne opto-electronic platform. First, the kinematic coupling relationship between different frames was analyzed according to mechanical characteristics of the system. Then,an improved DOB structure based on the velocity signal was proposed to restrain the impact of carrier disturbance, and its basic principle and robust stability were analyzed. Considering the disturbance such as the friction torque that exists in mechanical systems generally, a composite control method with a fuzzy controller was proposed to improve the tracking performance. Finally, the global stability and the asymptotic convergence of the tracking error were proved on the basis of Lyapunov stability theory. Experiment results show that the stabilization accuracy can reach a higher level and the tracking error has been μrad magnitude, which demonstrates that the proposed scheme in this paper can restrain the impact of carrier disturbance and improve the tracking performance effectively.

Keywords: airborne opto-electronic platform stabilization and tracking control of Line of Sight(LOS) disturbance observer(DOB) fuzzy system composite control Lyapunov stability

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