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### 基于干扰观测器的高超声速飞行器预测控制器设计

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### Design of Predictive Controller for Hypersonic Vehicles Based on Disturbance Observer

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摘要

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#### 摘要

针对具有强耦合特性与模型不确定性特点的高超声速飞行器控制问题, 提出一种新型的姿态预测控制器设计方法。引入参考模型, 建立了飞行器姿态预测控制模型。基于此, 利用预测理论设计了飞行器的预测控制器, 同时设计了干扰观测器实时观测外界未知干扰来进行补偿控制, 从而实现滚动优化的目的; 基于干扰观测值与真值的误差, 利用Lyapunov稳定性理论, 确定了控制精度与预测步长大小的关系; 最后, 在参数标称与拉偏的情形下进行了高超声速飞行器姿态控制系统仿真, 仿真结果表明, 干扰观测器能快速跟踪干扰, 并且所设计的预测步长可以满足飞行器高精度的控制要求。

关键词: 高超声速飞行器 预测控制 参考模型 干扰观测器 误差界限

#### Abstract:

A new kind of attitude controller based on the predictive control method is proposed for hypersonic vehicles with strong coupling characteristics and model uncertainties. Firstly, a novel predictive controller is presented according to the predictive control model combined with the dynamic model of a hypersonic vehicle and an expected reference model, a disturbance observer is designed to compensate timely for the controller and to satisfy the rolling optimization requirements. Secondly, the whole control system stability is strictly proven by Lyapunov stability theory based on the error between the observed value and the real value, and the control accuracy is determined by the predictive length. Finally, the performances and robustness are assessed through a hypersonic vehicle simulation analysis. Several simulation results all show that the predictive controller can guarantee stability and high control precision under the conditions of model parameter nominal and large-scale model parameter perturbation, and the disturbance observer can follow the tracks of the disturbance rapidly.

Keywords: hypersonic vehicles predictive control reference model disturbance observer error bounds

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