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过程系统工程

基于PDE降阶模型的最优控制

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摘要

针对带有约束条件的偏微分方程（PDE）模型最优控制的实时性要求和巨大的内存开销问题，提出了基于降阶模型的输入/状态约束的最优实时控制方法。采用特征正交分解和奇异值分解以及Galerkin投影方法导出了动态PDE具有高精度离散形式的状态空间低阶模型，提出了一定输入/状态约束条件下的基于二次规划单步滚动最优控制并与基于线性二次调节器的极值验证最优控制策略相互验证。通过对流-扩散-反应过程的控制仿真结果证明了所提方法的高效性和准确性。

关键词

对流-扩散-反应过程 特征正交分解 奇异值分解 降阶模型 最优控制

分类号

Optimal control based on reduced-order models of PDE

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Abstract

To solve the problem of optimal real-time control and large memory expense of partial differential equation（PDE）model with constraints，an approach is presented for optimal control with input/state constraints based on reduced-order model，which was derived from dynamic PDE in the form of a discrete-time low-order state-space model with high accuracy by using proper orthogonal decomposition（POD），singular value decomposition（SVD）and Galerkin projection. Then，by combining the reduced-order model,the modified optimal control method,the single-step rolling optimal control with certain input/state constraints based on quadratic programming which was demonstrated with the extremum validating optimal control based on linear quadratic regulator each other,was constructed. The controlling simulation results in the convection-diffusion-reaction process showed the efficacy and accuracy of proposed algorithm.

Key words

convection-diffusion-reaction process proper orthogonal decomposition singular value decomposition reduced-order model optimal control

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