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改进型Gappy POD翼型反设计方法

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Improved Airfoil Inverse Design Method Based on Gappy POD

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摘要

为了提高基本Gappy本征正交分解(POD)翼型反设计方法的精度,在原始方法快照采样过程中,调整参数化方法,并用已产生翼型中压力分布最接近目标压力分布的翼型替换基础扰动翼型,形成最优快照替换采样法。在迭代求解阶段,根据迭代产生的压力分布与迭代产生的翼型实际压力分布之间的误差,引入校正快照,并据此调整目标压力分布,形成校正迭代法。实际算例表明,最优快照替换采样法所采集快照张成的空间较原始采样法更接近设计目标。而校正迭代法较原始迭代法能明显提高反设计精度。但最佳模态数量的选择对于Gappy POD翼型反设计方法仍然是一个难点。

关键词： 翼型 反问题 本征正交分解 快照空间 校正

Abstract:

To improve the design accuracy of airfoils, a new sample method called the best snapshot replacement is proposed in this paper which is used during the sampling process of airfoil inverse design based on Gappy proper orthogonal decomposition (POD). Using this method, the baseline airfoil has to be replaced by an airfoil whose pressure distribution is closest to the target pressure distribution among the airfoils that have been generated. During the iteration process, a calibration step is added based on the principle that a calibration snapshot can be introduced. By the fitting error of pressure distribution estimated by POD. Then the target pressure distribution can be calibrated using this snapshot. Airfoil inverse design examples demonstrate that the new sample method can generate a set of snapshots which spans a space closer to the design target. Compared with the original method this calibration iteration method can improve the accuracy of design result obviously, while how to choose the optimal number of modes remains to be a difficult point for airfoil inverse design based on Gappy POD.

Keywords: airfoil inverse problem proper orthogonal decomposition snapshot space calibration

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