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流体力学与飞行力学

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适用于混合网格的约束最小二乘重构方法

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Constrained Least-squares Reconstruction Method for Mixed Grids

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摘要

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摘要 为强化边界条件对计算流体力学(CFD)计算中流场重构过程的影响,基于三维任意多面体混合网格,对一种约束最小二乘法进行了研究。通过对不同边界类型的透明化处理,统一了约束方程组的形式,从而简化了该方法的应用。为了充分吸收消去法和加权法各自求解约束方程组的优点,提出了混合采用两种方法的思路。针对层流平板研究了加权法中加权系数如何取值问题,数值实验表明加权系数取到5基本已经足够大。最后通过亚声速层流平板和跨声速湍流ONERA-M6算例对比了混合法、加权法与原始最小二乘法,计算结果表明:约束最小二乘法相比原始最小二乘法的流场重构更加准确,特别是对边界质量较差网格的计算优势更为突出;混合消去加权法相比单独采用加权法的计算结果也有所改善。

关键词: 混合网格 任意多面体 重构方法 约束最小二乘法 消去法 加权法

Abstract: In order to enforce the effect of boundary conditions on the solution reconstruction of computational fluid dynamics (CFD) simulation, a constrained least-squares method based on arbitrary polyhedral mixed grids is investigated. To make the method simpler, a uniform constrained system is constructed through treating different boundary conditions in the same way. To make use of the advantages of both the elimination approach and the weighting approach, a mixed method is provided to solve the constrained system. The numerical experiments based on laminar plates show that setting the weighting coefficient to 5 is large enough in the weighting approach. The numerical results of a subsonic laminar flow over a plate and a transonic turbulent flow over ONERA-M6 demonstrate that the constrained least-squares method is more accurate than the original least-squares method, especially when bad quality grids are used near the boundary, and that the mixed method shows improved results as compared with the weighting approach.

Keywords: mixed grid arbitrary polyhedral reconstruction method constrained least-squares method elimination wei-ghting

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