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基于隐式嵌套重叠网格技术的阻力预测

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Drag Prediction Based on Overset Grids with Implict Hole Cutting Technique

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摘要

采用一种多层多块隐式嵌套重叠网格技术,对美国国家航空航天局通用化研究模型(NASA-CRM)翼身平尾(WBT)组合体进行了数值模拟与分析。多层多块隐式嵌套重叠网格技术是结合多层多块嵌套重叠网格处理策略和隐式切割方法,在建立重叠网格之间的流场信息传递关系时,基于网格单元切割准则选择"最优"重叠单元而无需人工设定插值边界。对美国AIAA委员会召开的第4届阻力预测研讨会(DPW-4)提供的CRM WBT组合体生成4种不同密度的结构化多层多块嵌套重叠网格,并采用计算流体力学(CFD)方法进行数值计算和阻力预测,计算结果与CFL3D和OVERFLOW的结果进行了对比。数值模拟结果表明:计算得到的压力分布和极曲线与CFL3D和OVERFLOW的结果几乎相同,说明了隐式嵌套重叠网格技术的有效性,同时也验证了流场求解方法与程序的可靠性。当迎角增大到3°左右时,在机身与机翼、尾翼连接处出现明显的分离涡,影响CRM WBT组合体的气动特性。在阻力预测方面,增加网格密度能够提高阻力预测的精度。采用不同的湍流模型会导致升、阻力系数的计算结果存在一定的差异,因此,湍流模型的选择也是阻力预测需要考虑的因素。

关键词： 数值模拟 阻力系数 重叠网格 多层多块嵌套策略 隐式切割方法 翼身平尾组合体

Abstract：

A multi-layer multi-block overset grid technique is presented to accurately simulate the viscous flows around the wing-body-tail (WBT) configuration of a common NASA research model (CRM). Based on the hierarchical overset grid strategy and the implicit hole cutting algorithm, this technique selects the "best" cells located in the overlapped regions by the criterion of cell size, rather than bydetermining whether a computed cell is lying inside (hole cell) or outside (not a hole cell) of a specified region. Four types of grids are built for a CRM WBT configuration proposed in the fourth drag prediction workshop (DPW-4), and viscous flows around the configuration are analyzed by an in-house computational fluid dynamic (CFD) solver. The numerical results show that all the aerodynamic forces matched well with those of CFL3D and OVERFLOW, which demonstrates the accuracy and efficiency of the in-house CFD solver. When the angle of attack is larger than 3° , separation bubbles at the wing and tail trailing edge have some influence on the aerodynamic performance of the CRM WBT configuration. The overset grid density is used to study drag prediction, and computational drag is more accurate with larger sizes of grids. Because the two turbulence models present different predictions of the effect of lift-drag performance, selection of turbulence models is also worth considering on drag prediction.

Keywords： numerical simulation drag coefficient overset grids hierarchical grid system implicit hole cutting wing-body-tail configuration

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