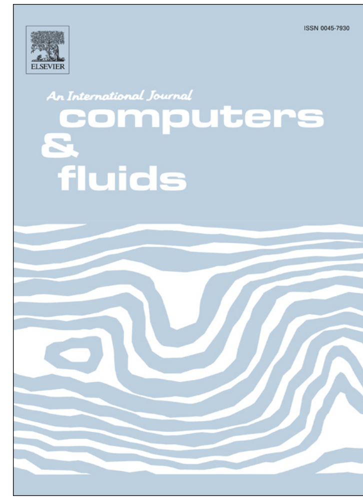
Accepted Manuscript



A family of hybrid cell-edge and cell-node dissipative compact schemes satisfying geometric conservation law

Xiaogang Deng, Yi Jiang, Meiliang Mao, Huayong Liu, Song Li, Guohua Tu

PII: S0045-7930(15)00130-9
DOI: http://dx.doi.org/10.1016/j.compfluid.2015.04.015
Reference: CAF 2864

To appear in: *Computers & Fluids*

Received Date: 10 June 2014
Revised Date: 8 April 2015
Accepted Date: 10 April 2015

Please cite this article as: Deng, X., Jiang, Y., Mao, M., Liu, H., Li, S., Tu, G., A family of hybrid cell-edge and cell-node dissipative compact schemes satisfying geometric conservation law, *Computers & Fluids* (2015), doi: http://dx.doi.org/10.1016/j.compfluid.2015.04.015

A family of hybrid cell-edge and cell-node dissipative compact schemes satisfying geometric conservation law

Xiaogang Deng[a,b], Yi Jiang[b,c,*], Meiliang Mao[b,c], Huayong Liu[b], Song Li[b], Guohua Tu[b]

[a] National University of Defense Technology, Changsha, Hunan, 410073, PR China
[b] State Key Laboratory of Aerodynamics, China Aerodynamics Research and Development Center, P.O. Box 211, Mianyang 621000, PR China
[c] Computational Aerodynamics Institute, China Aerodynamics Research and Development Center, P.O. Box 211, Mianyang 621000, PR China

Abstract

Growing evidences show that the Symmetrical Conservative Metric Method (SCMM) is essential in preserving freestream conservation and orders of accuracy for high-order finite difference schemes to simulate flows with complex geometries. In this paper, a new family of Hybrid cell-edge and cell-node Dissipative Compact Schemes (HDCSs) has been developed for geometry-complex flows by fulfilling the SCMM as well as by introducing dissipation according to the concept adopted in the construction of the high-order Dissipative Compact Schemes (DCSs). The resolution and dissipation properties of HDCSs are investigated by the Fourier analysis, and the stability property of HDCSs is also investigated by asymptotic stability analysis and amplification factor analysis. HDCSs are validated by computing several benchmark test cases. The vortex convection test case demonstrates that the orders of accuracy of the HDCSs are preserved unless the GCL is satisfied. Although high resolution of HDCSs is observed in the test of acoustic wave scattering of multiple cylinders, the solutions can be contaminated if the GCL is not satisfied. Moreover, the numerical solutions of flow past a high lift trapezoidal wing demonstrate the promising ability of the newly developed HDCSs in solving complex flow problems.

Keywords: High-order compact scheme, Hybrid cell-edge and cell-node Dissipative Compact Scheme, Geometric Conservation Law, Dissipative scheme, High lift trapezoidal wing

1. Introduction

Nowadays, compact high-order finite difference schemes have been widely used for a broad range of problems with multiple spatial and temporal scales such as turbulence and aeroacoustics [1]. The advantages of compact schemes using a compact stencil over traditional explicit finite difference schemes are mainly regarded as the relatively higher order of accuracy and higher resolution [2]. Although much advance has been achieved in constructing high-order compact schemes, applications of these schemes are still challenged by complex geometry. When the accurate numerical simulation of a broad spectrum phenomena is performed by

*Corresponding author.
Email address: yijiang@mail.ustc.edu.cn (Yi Jiang)