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A High-Order Unstructured Mixed Mesh Method for Aerodynamic Applications

Min Kyu Jung[1] and *Oh Joon Kwon[1]

[1]Department of Aerospace Engineering, KAIST, Korea.

*Corresponding author: ojkwon@kaist.ac.kr

A flow solver based on a mixed mesh paradigm is developed for resolving flows in a high-order accurate manner. The proposed mesh topology involves unstructured tetrahedral/prismatic mesh in the near-body region and adaptive Cartesian-based unstructured mesh in the off-body region. The body-confirming near-body unstructured mesh offers a great flexibility in treating complex geometries, and also ensures proper mesh resolution inside the boundary layer. For the Cartesian mesh in the off-body region, a high-order accurate WENO scheme was adopted to better resolve the detailed flow features. A multi-level mesh adaptation scheme with a tree-based data structure was also employed directly on the Cartesian cells to further enhance the accuracy of the solution. To transfer the flow information between the two mesh topologies, an overset mesh approach was applied. The accuracy and performance of the flow solver were validated for various fixed-wing and rotatory wing configurations.

Keywords: Mixed mesh, Adaptive Cartesian meshes, High-order WENO scheme, Adaptive mesh refinement