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Implementation of SU2 solver with cell-based data structure for 3D navier-stokes equations

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Statement of the problem: Partial Differential Equations (PDEs) in the open-source platform of Stanford University Unstructured (SU2) software suite are discretized using a finite volume method with a standard edge-based structure on a dual grid with control volumes constructed using a median-dual, vertex-based scheme. Hence, SU2 does not include the capability to handle the computational meshes containing hanging nodes, which are common in Cartesian grids. The purpose of this study is to develop a cell-based solution strategy in SU2 in order to eliminate the hanging node problem corresponding to Cartesian grids. In the present work, the node based structure of SU2 is converted to a cell-based approach, which is successfully used in complex 3D laminar and turbulent simulations and is also a very flexible and efficient method in terms of input grids.

Methodology: In cell-based data structure, the flow field is partitioned into a set of non-overlapping control volumes which cover the entire computational domain. As an assumption in cell-based data structure, solutions are defined at the centers of the primal grid cells with the primal cells serving as the control volumes. The exact solution of approximate Riemann problem by Roe is used as the Convective Numerical Method to compute the inviscid flux. As reconstruction scheme, Weighted Least Squares Reconstruction method is utilized to calculate the gradients of flow variables at the cell centroids. Moreover, the four stage Runge-Kutta method is employed as the temporal discretization scheme.

Consequence: The results of SU2 with cell-based data structure are compared to theory, experiment and other accepted computational results for a series of low Reynolds number flows.

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