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Parallel Cartesian grid refinement for 3D complex flow simulations[1] DIONYSIOS ANGELIDIS, FOTIS SOTIROPOULOS, St. Anthony Falls Laboratory, Department of Civil Engineering, 2 Third Avenue SE, Minneapolis, MN 55414, USA — A second order accurate method for discretizing the Navier-Stokes equations on 3D unstructured Cartesian grids is presented. Although the grid generator is based on the oct-tree hierarchical method, fully unstructured data-structure is adopted enabling robust calculations for incompressible flows, avoiding both the need of synchronization of the solution between different levels of refinement and usage of prolongation/restriction operators. The current solver implements a hybrid staggered/non-staggered grid layout, employing the implicit fractional step method to satisfy the continuity equation. The pressure-Poisson equation is discretized by using a novel second order fully implicit scheme for unstructured Cartesian grids and solved using an efficient Krylov subspace solver. The momentum equation is also discretized with second order accuracy and the high performance Newton-Krylov method is used for integrating them in time. Neumann and Dirichlet conditions are used to validate the Poisson solver against analytical functions and grid refinement results to a significant reduction of the solution error. The effectiveness of the fractional step method results in the stability of the overall algorithm and enables the performance of accurate multi-resolution real life simulations.

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