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A Newton-Krylov method with approximate Jacobian for implicit solution of Navier-Stokes on staggered overset-curvilinear grids with immersed boundaries[1] HAFEZ ASGHARZADEH, IMAN BORAZJANI, University at Buffalo SUNY — Time step-size restrictions and low convergence rates are major bottle necks for implicit solution of the Navier-Stokes in simulations involving complex geometries with moving boundaries. Newton-Krylov method (NKM) is a combination of a Newton-type method for super-linearly convergent solution of nonlinear equations and Krylov subspace methods for solving the Newton correction equations, which can theoretically address both bottle necks. The efficiency of this method vastly depends on the Jacobian forming scheme e.g. automatic differentiation is very expensive and Jacobian-free methods slow down as the mesh is refined. A novel, computationally efficient analytical Jacobian for NKM was developed to solve unsteady incompressible Navier-Stokes momentum equations on staggered curvilinear grids with immersed boundaries. The NKM was validated and verified against Taylor-Green vortex and pulsatile flow in a 90 degree bend and efficiently handles complex geometries such as an intracranial aneurysm with multiple overset grids, pulsatile inlet flow and immersed boundaries. The NKM method is shown to be more efficient than the semi-implicit Runge-Kutta methods and Jabobian-free Newton-Krylov methods. We believe NKM can be applied to many CFD techniques to decrease the computational cost.

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