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Fast pressure-correction method for incompressible Navier-Stokes equations in curvilinear coordinates ABHIRAM AITHAL, ANTONINO FERRANTE, University of Washington — In order to perform direct numerical simulations (DNS) of turbulent flows over curved surfaces and axisymmetric bodies, we have developed the numerical methodology to solve the incompressible Navier-Stokes (NS) equations in curvilinear coordinates for orthogonal meshes. The orthogonal meshes are generated by solving a coupled system of non-linear Poisson equations. The NS equations in orthogonal curvilinear coordinates are discretized in space on a staggered mesh using second-order central-difference scheme and are solved with an FFT-based pressure-correction method. The momentum equation is integrated in time using the second-order Adams-Bashforth scheme. The velocity field is advanced in time by applying the pressure correction to the approximate velocity such that it satisfies the divergence free condition. The novelty of the method stands in solving the variable coefficient Poisson equation for pressure using an FFT-based Poisson solver rather than the slower multigrid methods. We present the verification and validation results of the new numerical method and the DNS results of transitional flow over a curved axisymmetric body.

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