Determination of the Wall Function for Navier-Stokes Solutions on Cartesian Grids

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Cartesian grids have beneficiary effects in the solution of partial differential equations (PDEs) resulting from their characteristic form of discretized finite-volume representation, i.e. nonlinear Navier Stokes equations involving irregular and multielement boundaries.

A new flow solver is generated in Visual Studio by using object-oriented FORTRAN programming and is called GeULER-NaTURe (cartesian Grid generator with EULER Navier Stokes TURbulent flow solvEr) [1]. Viscous terms of Navier-Stokes equations and Spalart-Allmaras [2] turbulence model are implemented into solver.

Near the solid boundary, generally, wall function is established by universal law-of-the-wall coordinate, y^+ , presented by Spalding [3].

GeULER-NaTURe flow solver [1] is dealing with external turbulent flows with high Reynolds numbers around embedded boundaries, so that the wall-bounded flow approach should be followed to limit the resolution of the fine grids in the turbulent boundary layer. In this region, the wall function is employed for the coarse grid utilization at $30 \leq y^+ \leq 150$ instead of fine grids at $y^+ < 5$ thus eliminates stiffness problem owing to redundant refinement. The analytic solution suggested by Berger et al. [4] in place of Spalding formula is selected as the wall function predictor, since the proposed formula is an explicit function of velocity in contrast to Spalding formula. Turbulent viscosity required for SA relations is adapted from Frink's study [5].

References

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