HIGH PERFORMANCE COMPUTING FOR COMPRESSIBLE TURBULENT FLOW

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Abstract

The aim of the present research and development work is to develop the computer program to simulate the steady two-dimensional compressible turbulent flow. The finite volume method is used to numerically solve the flow governing equations. The Navier-Stokes equations are solved for the velocity field and the SIMPLE algorithm is used to adjust the velocity field to satisfy the conservation law of mass. Since all the variables are stored at the center of each control volume, the Rhie-Chow interpolation is used to avoid the decoupling between the velocity and the pressure. The corrected velocity field is used to solve the $k-$ and $\varepsilon-$equations. The eddy viscosity, that represents the influence of turbulence on the mean flow field, can then be calculated from those values of k and ε obtained. The energy equation is solved for the temperature field. The effects of temperature and pressure on the fluid density are taken into account via the equation of state. The boundary layer on a flat plate is employed as a test case because it is one of the standard benchmark problems for the validation of CFD software. The sequential-computing solver is first used to obtain the computed results. It is found that the computed results are in good agreement with the experimental data at subsonic speed. The parallel-computing solver is also implemented here and tested against the sequential-computing one. It is found that the parallel program can run faster than the sequential one up to 2.55 times for the best case. Furthermore, the governing equations are solved on the structured and body-fitted coordinates so that this computer program can be developed further for the simulation of flow over or inside any object of complex geometry in the future.

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