Review of Vorticity-Based Methods for Viscous Flow Simulations

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Abstract

This paper presents a comparative study of numerical solutions obtained by two vorticity-based integral approaches for solving the two-dimensional incompressible Navier-Stokes equations. In the first one, an Eulerian finite volume scheme is implemented to solve the vorticity transport equation with a vorticity boundary condition. The Biot-Savart integral is used to compute the velocity field from a vorticity distribution over a fluid domain. In the second one, vortex particles are evolved by the Lagrangian description, and the Biot-Savart integral with a smoothed kernel instead are used. The vorticity boundary condition is improved by using an iteration scheme connecting with the conventional panel method. For the early stage development of the flow around an impulsively started circular cylinder, the computational results obtained by the Lagrangian vortex method are compared with those by the Eulerian finite volume method.

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