A weighted meshfree collocation method for incompressible flows using radial basis functions

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Abstract: A weighted strong form collocation method using radial basis functions and explicit time integration is proposed to solve the incompressible Navier-Stokes equations. The velocities and pressure are solved directly at the same time step and the continuity equation is satisfied at each time step which improve the solution accuracy and stability. No artificial compressibility coefficient should be introduced to model the incompressible flow and no pressure oscillation arises in the numerical solutions. Optimal convergence can be achieved by imposing the derived proper weights on the boundaries. Radial basis collocation method in a Lagrangian form is quite easy to capture the moving boundary or free surface in flow problems. Moreover, solid boundary conditions can be enforced directly and no special treatments should be employed. Further, critical time step for the explicit time integration is predicted in the stability analysis and the influences on the stability are evaluated. Numerical studies validate the high accuracy as well as good stability of the presented method.

Keywords: strong form collocation, radial basis functions, explicit time integration, incompressible Navier-Stokes equations, optimal convergence, stability analysis