Radial Basis Collocation Method for Incompressible Elasticity

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A strong form collocation framework based a pressure-displacement mixed formulation is proposed for incompressible and nearly incompressible linear elasticity. Both displacement and pressure fields are approximated by radial basis functions, and proper weights associated with incompressibility constraint and boundary condition collocation equations have been derived for balanced errors between domain, boundaries, and constraint equations to achieve optimal convergence. In the proposed method more collocation points than source points are used, which leads to an overdetermined system of collocation equations. The system of collocation equations is solved by a least-squares method; therefore, the pressure and displacement approximations are not subject to the LBB stability condition. The numerical studies show that the solution of the proposed method does not exhibit volumetric locking and pressure oscillation, and that the solution converges exponentially in both L_2 norm and H_1 semi-norm, consistent with the error analysis results presented in this paper. The same set of radial basis functions for displacement and pressure can be used to obtain extremely accurate solution in both fields without encountering the well-known numerical defects in the limit of incompressibility making this proposed method very attractive for incompressible problems.

Keywords: collocation method, radial basis function, incompressible, mixed formulation