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NEW LOCAL RADIAL BASIS COLLOCATION METHOD IMPLEMENTATION FOR SOLVING STOKES FLOW IN VELOCITY-VORTICITY FORMULATION

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Abstract. It is well-known that full-domain Radial Basis Function collocation methods (LRBCM), such as original unsymmetric and symmetric versions, suffer severe ill-conditioning and consequently poor accuracy as the number of collocation points increase or RBF shape parameter becomes flatter. Further drawback in collocation or strong form based numerical methods for solving partial differential equations is related with decreasing of accuracy when the imposition of natural boundary condition is accounted. For taking into account the domain decomposition principle, alternate approaches can be devised for mitigating the large populated matrix work. A very promising alternative uses the concept of local RBF interpolation with overlapping multi-domains in the context of a point collocation technique. Recently, it has been proposed that a differential operator discretization through local generalized Hermite RBF interpolation leading to a linear combination between weighting coefficients, unknown field solutions and given derivative functional values in the vicinity of a given collocation point can attain a high order method and to improve the accuracy at and near to Neumann boundaries. Further advantage of this approach has been reported in the context of a combination between standard control volume method and local Hermite RBF interpolation for solving successfully 3D linear convection-diffusion problems for high Péclec number. It is explained that the flow information including at PDE operator for constructing locally RBF interpolating approximations provides a effect of “analytical” upwinding which enhanced the control volume method capability for predicting highly accurate solution and free of spurious oscillations without any other artifacts.

In this paper, we devise a scheme for solving Stokes flow problems, i.e. $Re = 0$, subject to no-slip boundary conditions in velocity-vorticity formulation using the enjoyed version of the local RBF collocation method including PDEs information. An uncoupled numerical procedure along with the derived PDE–LRBFCM and the simplest LRBFCM are used and their solutions compared. The benchmark solution was obtained with the dual reciprocity boundary element method (BEM). As is expected, the velocity profiles along the geometric centers of a lid driven flow obtained with LRBFCM including PDEs information are in excellent agreement with the reference solution, whereas the simplest counterpart under-predicts the picks of velocities.