Robust Numerical Solution for Flow Problems

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Abstract : Simple and robust numerical approach for solving flow problems is presented, where involved physical fields are represented through the local approximation functions, i.e., the considered field is approximated over a local support domain. The approximation functions are then used to evaluate the partial differential operators. The type of approximation, the size of support domain, and the type and number of basis function can be general. The solution procedure is formulated completely through local computational operations. Besides local numerical method also the pressure velocity is performed locally with retaining the correct temporal transient. The complete locality of the introduced numerical scheme has several beneficial effects. One of the most attractive is the simplicity since it could be understood as a generalized Finite Differences Method, however, much more powerful. Presented methodology offers many possibilities for treating challenging cases, e.g. nodal adaptivity to address regions with sharp discontinuities or p-adaptivity to treat obscure anomalies in physical field. The stability versus computation complexity and accuracy can be regulated by changing number of support nodes, etc. All these features can be controlled on the fly during the simulation. The presented methodology is relatively simple to understand and implement, which makes it potentially powerful tool for engineering simulations. Besides simplicity and straightforward implementation, there are many opportunities to fully exploit modern computer architectures through different parallel computing strategies. The performance of the method is presented on the lid driven cavity problem, backward facing step problem, de Vahl Davis natural convection test, extended also to low Prandtl fluid and Darcy porous flow. Results are presented in terms of velocity profiles, convergence plots, and stability analyses. Results of all cases are also compared against published data.

Keywords : fluid flow, meshless, low Pr problem, natural convection
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