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A Weighted Optimal Least-Squares Finite Element Method for CFD in Multi-Physics Simulations

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Abstract

The Least-Squares Finite Element Method (LSFEM) has been around for decades. Recent developments have demonstrated both theoretical completeness and numerical stability of the optimal LSFEM[1] in incompressible fluid dynamics applications. Along with the wider applications of LSFEM, researchers and practitioners have observed, in certain ranges of CFD problems, some different levels of non-conservative behavior pending on the least-squares formulations. Specifically noticeable terms are the mass conservation in incompressible flow calculations[2].
In this paper, numerical results of different levels of conservation inconsistency are presented. By carefully examining the optimal LSFEM equations and the solution process, it is observed that the equal-weighting nature of the LSFEM formulation is the numerical culprit of such conservation problem. As the additional variables in multi-physics simulations are included, the non-conservative behavior becomes more pronounced. A numerical weighting method is proposed to solve the least-squares first order differential equations by selectively imposing higher weighting on the critical mass conservation equation based on the actual physical properties of the problem. Improved numerical results using such weighted optimal least-squares method are presented to demonstrate the applicability to general problems. Several possible refinement approaches are also discussed.

REFERENCES

[1] B. N. Jiang, L. A. Provinelli, *Optimal least-squares finite element method for elliptical problems,* Comp. Meth. Appl. Mech. Engrg., 102, (1993), 199-212.
[2] H. T. Lin, T. L. Lin, *An optimal least-squares finite element method with h-p adaptivity for CFD and conjugate heat transfer,* 4th National Congress on Computational Mechanics, (1997).