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The use of dual reciprocity method for 2D laminar viscous flow

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Abstract. The paper presents the use of the dual reciprocity multidomain singular boundary method (SBMDR) for the solution of the laminar viscous flow problem described by Navier-Stokes equations. A homogeneous part of the solution is solved using a singular boundary method with the 2D Stokes fundamental solution - Stokeslet. The dual reciprocity approach has been chosen because it is ideal for the treatment of the nonhomogeneous and nonlinear terms of Navier-Stokes equations. The presented SBMDR approach to the solution of the 2D flow problem is demonstrated on a standard benchmark problem - lid-driven cavity.

1 Introduction

The solution of Navier–Stokes (NS) equations is one of the basic tasks of computational fluid mechanics. This nonlinear system of differential equations has already been solved by a number of numerical methods, starting with the finite difference method through the finite element method to meshless and boundary type methods. The methods based on boundary integral theory are represented by the local boundary integral element method (LBIEM) [1], the boundary element method (BEM) [2], [3], the method of fundamental solutions (MFS) [4] and the singular boundary method (SBM) [5]. In the case of BEM the singularities of the fundamental solution are handled by proper integration method, the MFS overcomes the singularity using a fictitious boundary, but the optimum location of this boundary remains the open problem especially for complex-shaped domains. To bypass the fictitious boundary construction, the SBM formulation adopts a concept of the origin intensity factors (OIFs). Several techniques have been developed to determine the source intensity factors, namely, inverse interpolation technique (IIT), subtracting and adding-back regularization and empirical formulas [5], [6].

In this article, the solution of the steady fluid flow governed by the primitive variable form of Navier-Stokes (NS) equations is presented. The SBM with dual reciprocity (DR) technique is used to handle the nonlinear convection terms of NS equations.

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generates a sparse characteristic matrix and enables the method to obtain reasonable results even for high Reynolds numbers. The presented numerical code and numerical results need to be more analyzed in the sense of precision, convergence and computational demands.

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References

1. K. Kovářík, D. Sitányiová, J. Mužík, Eng. Anal. Bound. Elem. **44**, 55-63 (2014)
2. C.A. Brebbia, *Boundary Element Techniques in Engineering*. (Elsevier, 2016)
3. P. Partridge, *Dual Reciprocity Boundary Element Method*. (Springer Science & Business Media, 2012)
4. M.A. Golberg, *Boundary Integral Methods - Numerical and Mathematical Aspects* (WIT Press, 1998)
5. K. Kovářík, J. Mužík, S. Masarovičová, D. Sitányiová, Eng. Anal. Bound. Elem. **95**, 85-92 (2018)
6. Šarler, B., Eng. Anal. Bound. Elem. **33**, 1374-1382 (2009)
7. X. Wei, W. Chen, L. Sun, B. Chen, Eng. Anal. Bound. Elem. **58**, 151-165 (2015)
8. W. Chen, Z. Fu, X. Wei, CMES-Comp. Model. Eng **54**, 65–85 (2009)
9. W.F. Florez, *Nonlinear flow using dual reciprocity*. (WIT Press, 2001)
10. T.A. AbdelMigid, K.M. Saqr, M.A. Kotb, A.A. Aboelfarag, Alex. Eng. J. **56**, 123-135 (2016)