Boundary Element Analysis of steady incompressible viscous flow with isogeometric and isoparametric discretisation

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ABSTRACT

In this work the boundary element method (BEM) is applied to steady incompressible viscous flow of Newtonian fluids. The boundary integral equation is derived from the continuity and momentum equation and the primary variables involved are velocity and traction [1]. Due to the non-linearity of the governing differencial equation a volume integral arise in the formulation of the final equation system. Thus, iterative techniques, either a full or modified Newton-Raphson algorithm, are applied in the solution procedure.

The numerical discretisation is done in two different ways, firstly with the use of classical isoparametric continuous elements of linear and quadratic order. Using this type of elements geometry- and mesh-generation is a significant portion of the overall computation effort. In contrast to this, in a second implementation, the discretisation is done with the isogeometric analysis (IGA) [2]. With the IGA geometry data can be taken directly from Computer Aided Design (CAD) programs [3], potentially eliminating the need for mesh generation. The arising surface and volume integrals of the BEM are evaluated with both techniques, the isoparametric application and with the IGA.

Computational results are shown for the two different numerical implementations based on 2D benchmark examples. The accuracy of the results of both methods are compared as well as the computational effort, such as numbers of degrees of freedom and computation times.

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