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Highly accurate surface and volume integration on implicit domains by means of moment-fitting

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SUMMARY

We introduce a new method for the numerical integration over curved surfaces and volumes defined by a level set function. The method is based on the solution of a small linear system based on a simplified variant of the moment-fitting equations. Numerical experiments suggest that the accuracy of the resulting quadrature rules exceeds the accuracy of traditional methods by orders of magnitude. Using moments up to an order of p, the measured experimental orders of convergence exceed h^p. Consequently, their construction is very efficient because only coarse computational grids are required. The conceptual simplicity allows for the application on very general grid types, which is demonstrated by numerical experiments on quadrilateral, triangular and hexahedral grids. Copyright © 2013 John Wiley & Sons, Ltd.

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KEY WORDS: quadrature; numerical integration; level set; extended finite element method; discontinuous Galerkin method; finite cell method

1. INTRODUCTION

In this paper, we present methods for the numerical integration of functions over domains that are at least partly defined by the zero iso-contour of a level set function. Such integrals commonly appear in many methods dealing with non-trivial internal or external interfaces that are not aligned with the computational grid (e.g., see [1]).

Within the past decade, sharp-interface methods that strive to resolve local effects with sub-cell accuracy have gained more and more interest. Examples include the eXtended Finite Element Method [2–4], the Finite Cell Method [5] and the discontinuous Galerkin method [6–8]. All those methods share the property that part of the burden of discretization is shifted to the numerical integration of generic functions over complicated, typically curved domains where conventional quadrature rules are hard if not impossible to construct. As a consequence, the viability of the extension of these methods to higher approximation orders is always directly linked to the affordable integration accuracy.

Many measures to cope with this issue have been proposed in literature. A long-known class of methods proposes to replace the sharp interface by smeared transition functions for the sake of numerical integration [1, 9–13]. The smeared integrand may then be integrated via standard quadrature rules, which renders the method appealing because of its simplicity. However, it is hard to control the width of the smearing region without generating excessive errors, and thus, their accuracy tends to be very limited on general grids.

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Finite Elements in Fluids (Wiley Series in Numerical Methods in Engineering) (Volume 3) [Richard H. Gallagher, O. C. Zienkiewicz, J. Tinsley Oden.Frey P., George P.L., Mesh generation, application to finite element methods, Wiley, (); Johnson C., Numerical solution of partial differential equations by.The International Journal for Numerical Methods in Biomedical Engineering (IJNMBE) Coordinate Transformation Aided Finite Element Method for Contour .Home >; Mechanical Engineering >; Computational / Numerical Methods >; International Journal for - Volume International Journal for Numerical Methods in Fluids - Volume Volume 52, Issue 3, Pages , 30 September Special Issue: Finite Element for Flow Problems (FEF) Part 1.Professor O.C. Zienkiewicz, CBE, FRS, FREng is Professor Emeritus and Director of the Institute for Numerical Methods in Engineering at the University of Wales.blanktitlemusic.com - Buy Finite Elements in Fluids: Viscous Flow and Hydrodynamics (Wiley Series in Numerical Methods in Engineering) book online at best prices in India on blanktitlemusic.com Read Finite Hardcover from 3 Used from blanktitlemusic.com - Buy Finite Elements in Fluids: Volume 7: (Wiley Series in Numerical Methods in Engineering) book online at best prices in India on blanktitlemusic.comR. W. Lewis, and K. G. Stagg. Finite Elements in Fluids. Vol. 3. Edited by R. H. Gallagher. . (Wiley series in numerical methods in engineering).About Finite Element Analysis of Fluid Structure Interaction Problems? [3]: Bathe K.J., Zhang H., Zhang X. Some advances in the analysis of fluid flows. R. Fluid Structure Interaction: Applied Numerical Methods, John Wiley & Sons, . //International Journal for Numerical Methods in Engineering. , Vol.The main objective of the Journal Numerical Methods in Fluids is to provide a timely and These include but are not limited to the Finite Difference and Finite Element to engineering problems and demonstrated to be effective will be published. . A new finitevolume flow solver based on the hybrid Cartesian immersed.for a direct numerical solution (DNS) or some limiting procedure is used by Isothermal flow of viscous fluid is governed by balance equations of mass and . of the balance equations in a control volume with the domain velocity, we . Continuous finite elements are used for all simulations in three-dimensional (3D) space.Computational fluid dynamics (CFD) is a branch of fluid mechanics that uses numerical analysis and data structures to . The finite volume method (FVM) is a common approach used in CFD codes, The finite element method (FEM) is used in structural analysis of solids, but is also applicable to fluids. .. Wiley Interscience.Baker, A.J. Finite Element Computational Fluid Dynamics, Series in Calculations, International Journal of Computational Fluid Dynamics, Vol. 16, No. 3, pp. Hirsch, C. Numerical Computation of Internal and External Flows, Vol. I Huebner, K.H. The Finite-Element Method for Engineers, John Wiley and.Aravas, N., On the Numerical Integration of a Class of Pressure-Dependent Plasticity Models, International Journal for Numerical Methods in Engineering, vol. . Desai, C. S., Finite Element Methods for Flow in Porous Media in Finite Elements in Fluids for Fluid-Structure Interaction, Journal of Sound and Vibration, vol.If you are searching for the

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