

Stability Estimates of the Mortar Finite Element Method for 3-Dimensional Problems

Dietrich Braess, Wolfgang Dahmen

Abstract

This paper is concerned with the mortar finite element method for three spatial variables. The two main issues are the proof of the LBB condition based on appropriate choices of Lagrange multipliers and optimal efficiency of corresponding multigrid schemes for the whole coupled systems of equations. The implementation of the smoothing procedure also differs from that one used in the 2-dimensional case.

Key words: Mortar method, domain decomposition, saddle point problems, L_2 -stability of mortar projections, multigrid algorithms, error estimates, efficiency of smoothing procedures.

AMS subject classification: 65N55, 65N30, 65F10, 46E35.

1 Introduction

The mortar method is a domain decomposition method with non-overlapping subdomains, see e.g. [1, 2, 3, 6]. The matching of discretizations on adjacent subdomains is only enforced weakly which, in particular, facilitates employing *different types* of discretizations on different subdomains. Even in the case when only finite elements are used on each subdomain, and this is the setting to be treated here, this still offers, in principle, the advantage of freely choosing highly varying mesh sizes on different subdomains. This is a very promising feature with regard to abruptly changing diffusion coefficients or local anisotropies.

We view such types of *physical properties* of the underlying problem as a major motivation for employing a mortar technique rather than parallelization. Therefore we are primarily interested in developing highly efficient *multigrid schemes* for the whole coupled system of equations.

In a recent paper [6] such a multigrid algorithm for mortar elements was developed and analyzed with primary focus on the case of two spatial variables. The analysis heavily

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The Finite Element Method for Three-Dimensional Thermomechanical Applications Guido Dhondt, 2004-11-19

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Proceedings of International Conference on Finite Element Methods International Conference on Finite Element Methods, 2001 *Finite Element Method for Eigenvalue Problems in Electromagnetics* C. J. Reddy, 1994

Finite Element Methods: Basic Concepts And Applications Darrell W. Pepper, Juan C. Heinrich, 1992-02-01 Deals with the fundamentals of the finite element method Beginning with the concept of one dimensional heat transfer the book progresses through two dimensional elements and ultimately ends with a discussion on three dimensional elements Each chapter contains a set of example problems and exercises Overall the book is useful in describing how to develop and utilize finite element methodology to numerically solve problems

Finite Element Method Electromagnetics John L. Volakis, Arindam Chatterjee, Leo C. Kempel, 1998-06-15 Employed in a large number of commercial electromagnetic simulation packages the finite element method is one of the most popular and well established numerical techniques in engineering This book covers the theory development implementation and application of the finite element method and its hybrid versions to electromagnetics FINITE ELEMENT METHOD FOR ELECTROMAGNETICS begins with a step by step textbook presentation of the finite method and its variations then goes on to provide up to date coverage of three dimensional formulations and modern applications to open and closed domain problems Worked out examples are included to aid the reader with the fine features of the method and the implementation of its hybridization with other techniques for a robust simulation of large scale radiation and scattering The crucial treatment of local boundary conditions is carefully worked out in several stages in the book Sponsored by IEEE Antennas and Propagation Society

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Finite Element Method with Applications in Engineering Y. M. Desai, 2011. The book explains the finite element method with various engineering applications to help students teachers engineers and researchers. It explains mathematical modeling of engineering problems and approximate methods of analysis and different approaches.

The Finite Element Method in Engineering Singiresu S. Rao, 2017-10-31. The Finite Element Method in Engineering Sixth Edition provides a thorough grounding in the mathematical principles behind the Finite Element Analysis technique an analytical engineering tool originated in the 1960 s by the aerospace and nuclear power industries to find usable approximate solutions to problems with many complex variables. Rao shows how to set up finite element solutions in civil mechanical and aerospace engineering applications. The new edition features updated real world examples from MATLAB Ansys and Abaqus and a new chapter on additional FEM topics including extended FEM X FEM. Professional engineers will benefit from the introduction to the many useful applications of finite element analysis. Includes revised and updated chapters on MATLAB Ansys and Abaqus. Offers a new chapter Additional Topics in Finite Element Method. Includes discussion of practical considerations errors and pitfalls in FEM singularity elements. Features a brief presentation of recent developments in FEM including extended FEM X FEM augmented FEM A FEM and partition of unity FEM PUFEM. Features improved pedagogy including the addition of more design oriented and practical examples and problems. Covers real life applications sample review questions at the end of most chapters and updated references.

Applied Mechanics Reviews, 1976

Semiconductor Device Modelling Christopher M. Snowden, 2012-12-06. Semiconductor device modelling has developed in recent years from being solely the domain of device physicists to span broader technological disciplines involved in device and electronic circuit design and development. The rapid emergence of very high speed high density integrated circuit technology and the drive towards high speed communications has meant that extremely small scale device structures are used in contemporary designs. The characterisation and analysis of these devices can no longer be satisfied by electrical measurements alone. Traditional

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The Finite Element Method in Electromagnetics Jian-Ming Jin, 2015-02-18 A new edition of the leading textbook on the finite element method incorporating major advancements and further applications in the field of electromagnetics The finite element method FEM is a powerful simulation technique used to solve boundary value problems in a variety of engineering circumstances It has been widely used for analysis of electromagnetic fields in antennas radar scattering RF and microwave engineering high speed high frequency circuits wireless communication electromagnetic compatibility photonics remote sensing biomedical engineering and space exploration The Finite Element Method in Electromagnetics Third Edition explains the method's processes and techniques in careful meticulous prose and covers not only essential finite element method theory but also its latest developments and applications giving engineers a methodical way to quickly master this very powerful numerical technique for solving practical often complicated electromagnetic problems Featuring over thirty percent new material the third edition of this essential and comprehensive text now includes A wider range of applications including antennas phased arrays electric machines high frequency circuits and crystal photonics The finite element analysis of wave propagation scattering and radiation in periodic structures The time domain finite element method for analysis of wideband antennas and transient electromagnetic phenomena Novel domain decomposition techniques for parallel computation and efficient simulation of large scale problems such as phased array antennas and photonic crystals Along with a great many examples The Finite Element Method in Electromagnetics is an ideal book for engineering students as well as for professionals in the field

The Finite Element Method and Its Reliability Ivo Babuška, Theofanis Strouboulis, 2001 The finite element method is a numerical method widely used in engineering Experience shows that unreliable computation can lead to very serious consequences Hence reliability questions stand more and more at the forefront of engineering and theoretical interests The

present book presents the mathematical theory of the finite element method and focuses on the question of how reliable computed results really are. It addresses among other topics the local behaviour errors caused by pollution superconvergence and optimal meshes. Many computational examples illustrate the importance of the theoretical conclusions for practical computations. Graduate students, lecturers and researchers in mathematics, engineering and scientific computation will benefit from the clear structure of the book and will find this a very useful reference. *Finite Element Analysis in*

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The work examines popular constitutive models, numerical techniques and case studies. **COMPUTATIONAL MODELS -**

Volume II Shaidurov Vladimir Viktorovich, 2009-04-10. Computational Models is a component of Encyclopedia of Mathematical Sciences in the global Encyclopedia of Life Support Systems EOLSS which is an integrated compendium of twenty one Encyclopedias. Modern Computational Mathematics arises in a wide variety of fields including business, economics, engineering, finance, medicine and science. The Theme on Computational Models provides the essential aspects of Computational Mathematics emphasizing Basic Methods for Solving Equations, Numerical Analysis and Methods for Ordinary Differential Equations, Numerical Methods and Algorithms, Computational Methods and Algorithms, Numerical Models and Simulation. These two volumes are aimed at those seeking in depth of advanced knowledge: University and College students, Educators, Professional practitioners, Research personnel and Policy analysts, managers and decision makers and NGOs.

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Zienkiewicz, R. L. Taylor, J. Z. Zhu, 2005-05-26. The Sixth Edition of this influential best selling book delivers the most up to date and comprehensive text and reference yet on the basis of the finite element method (FEM) for all engineers and mathematicians. Since the appearance of the first edition 38 years ago, The Finite Element Method provides arguably the

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Scientific and Technical Aerospace Reports, 1991

Finite Element Methods 卐, Jiafu Lin, 2007-11-28 Distributed by Elsevier Science on behalf of Science Press This book discusses the accuracy of various finite element approximations and how to improve them with the help of extrapolations and super convergence's post processing technique The discussion is based on asymptotic expansions for finite elements and finally reduces to the technique of integration by parts embedding theorems and norm equivalence lemmas The book is also devoted to explaining the origin of theorems Masterly exposition of the accuracy and improvement of finite element methods highlighting the postprocessing Emphasis on understanding of higher knowledge Accessible to students engaging for experts and professionals Written by leading Chinese mathematicians available internationally for the first time

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