SEMA SIMAI Springer Series

Volume 5

More information about this series at
http://www.springer.com/series/10532

Simona Perotto • Luca Formaggia
Editors

New Challenges in Grid Generation and Adaptivity for Scientific Computing

Springer

Editors
Simona Perotto
MOX Dipartimento di Matematica
Politecnico di Milano
Milano
Italy

Luca Formaggia
MOX Dipartimento di Matematica
Politecnico di Milano
Milano
Italy

ISSN 2199-3041 ISSN 2199-305X (electronic)
SEMA SIMAI Springer Series
ISBN 978-3-319-06052-1 ISBN 978-3-319-06053-8 (eBook)
DOI 10.1007/978-3-319-06053-8

Library of Congress Control Number: 2015937357

Springer Cham Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

Preface

This volume presents selected contributions from the Fourth Tetrahedron Workshop on Grid Generation for Numerical Computation, which was held in Verbania, Italy, in July 2013. The previous editions of this workshop have been hosted by the Weierstrass Institute in Berlin, Germany, in 2005, by INRIA Rocquencourt, France, in 2007, and by Swansea University, United Kingdom, in 2010.

The goal of this book is to present recent developments in mesh generation and adaptation, with emphasis on applications to different fields of interest in science and engineering. Mesh generation is a crucial aspect of numerical simulation of problems governed by partial differential equations. Almost all discretization methods for this large class of problems rely on partitioning the computational domain into a set of elements that form a tessellation of the domain of interest. These elements are used either to define the support of the basis of the approximating space (in finite element or spectral element formulations) or as the basic unit for the setup of the discrete problem (as in a finite volume framework).

As a consequence, their shape and distribution may considerably affect the quality and accuracy of the numerical solution. One of the issues tackled in this book is how to efficiently generate a mesh that ensures a certain bound of the error between the exact solution and a corresponding discretization. This is normally accomplished by resorting to either *a priori* or *a posteriori* bounds relating the discretization error to the element size, shape, and orientation, often through the definition of a solution-dependent metric.

Things are even more difficult when dealing with realistic three-dimensional domains, whose boundary can be extremely complex and non-planar. In such cases, the control of the error induced by the discretization of the physical boundary is also demanded. Thus, the generation of good surface meshes and the control of mesh quality near the domain boundary become crucial tasks.

Another more practical issue is how to generate or adapt the mesh in an automatic and computationally efficient manner. Since mesh generation is often one of the most time-consuming issues in simulations applied to engineering problems, research on this topic is of great importance for real-life applications and deserves methodical investigation.

With the contributions in this book, we cover different, though related, aspects in the field of mesh generation and adaptation: the generation of quality grid for complex three-dimensional geometries, with some contributions on parallel techniques; mesh adaptation, addressing both theoretical and implementation aspects; and mesh generation and adaptation on surface — all with an interesting mix of numerical analysis, computer science, and strongly applicative problems.

It was the intention of the editors and organizers of the workshop to bring together mathematicians, engineers, and industrial researchers. This explains the variety of the contributions, which, in our opinion, gives added value to this work. The book is thus addressed to the numerical analysis and scientific computing community as well as to industrial researchers or software engineers who wish to keep abreast of the state of the art in the field of mesh generation and adaptation.

We wish to acknowledge the institutions and companies that have supported the workshop and thus made possible the production of this monograph: the Comune di Verbania, the Istituto Nazionale di Alta Matematica "F. Severi" (INDAM), the Department of Mathematics of Politecnico di Milano and, in particular, its laboratory for Modeling and Scientific Computing (MOX), Springer Italy, MOXOFF S.r.L., and Beta CAE System. The workshop was held under the auspices of Società Italiana di Matematica Applicata e Industriale (SIMAI).

Special thanks are also due to Laura Guarino and Anna Rho of the EventiMate staff of the Department of Mathematics of Politecnico di Milano for their precious help in organizing the event.

Milan, Italy — Simona Perotto
September 2014 — Luca Formaggia

Contents