Journal of Applied Mechanics

Preface

Special Issue on Stabilized, Multiscale, and Multiphysics Methods in Fluid Mechanics

This special issue of the *Journal of Applied Mechanics* is based on the ASME International Mechanical Engineering Congress and Exposition ASME05 and ASME06. The mini-symposium on *Challenges and Advances in Flow Simulation and Modeling: Fundamental and Enabling Technologies* was held at ASME05 in Orlando, Florida, November 5–11, 2005, and the mini-symposium on *Stabilized, Multiscale and Multiphysics Methods* was held at ASME06 in Chicago, Illinois, November 5–10, 2006. The scope of the two symposia included all aspects of the stabilized and multiscale finite element methods as well as their applications to coupled fluid-structure interaction problems. The papers presented at the two symposia included (i) mathematical theory of the stabilized and multiscale finite element methods, (ii) new stabilized formulations, (iii) stabilized methods applied to fluid-structure interaction problems, (iv) large scale computations with stabilized methods, and (v) application of stabilized methods to biofluid dynamics.

This special issue contains 12 papers that present a spectrum of physical problems where stabilized methods have been applied.

The paper by Catabriga, Souza, Coutinho and Tezduyar presents inviscid compressible flow calculations with the *YZB* shock-capturing parameter. The shock-capturing parameter based on conservation variables is compared with a parameter based on the entropy variables, and a sequence of numerical tests including 1D, 2D and 3D examples are presented.

Rispoli, Saavedra, Menichini and Tezduyar present an application of the *YZB* shock capturing technique integrated in a variable subgrid scale formation for inviscid supersonic flows. They show a variety of test problems for high Mach number flows.

Corsini, Menichini, Rispoli, Santoriello and Tezduyar develop a stabilization technique that is based on a variational multiscale method. Their technique includes a discontinuity-capturing term designed to be operative when the solution gradients are high and the reaction-like terms are dominant. They show applications of their method on a sequence of 2D and 3D problems.

The work by Manguoglu, Saied, Sameh, Tezduyar and Sathe presents new preconditioning techniques for solving the nonsymmetric systems that arise from the discretization of the Navier–Stokes equations. They also show the effectiveness of their proposed techniques for handling time-accurate as well as steady-state solutions.

The work by Houseman, Kiris and Hafez presents time-derivative preconditioning methods for numerical simulation of inviscid multicomponent and multiphase flows. Their paper deals with Riemann problems and presents two-dimensional applications. The time-derivative preconditioned system of equations is shown to be hyperbolic in time and well-conditioned in the incompressible limit.

The work by Takagi, Yamada, Gong and Matsumoto presents an application of fluid mechanics to biofluid dynamics and to the deformation of vesicles in a shear flow.

The paper by Cruchaga, Celentano and Tezduyar presents the numerical and experimental analyses of the collapse of a water column over an obstacle. Their computational model is based on a stabilized formulation that is integrated with a moving interface technique, namely the Edge-Tracked Interface Locator Technique (ETILT) to calculate the evolution of the water-air interface.

A vector extrapolation method for strong coupling of the fluid-structure interaction solvers is presented by Kuttler and Wall. They consider the case of an incompressible fluid and nonlinear elastodynamics, and present polynomial based vector extrapolation schemes that are then applied to coupled FSI problems.

Brummelen presents the added mass effects of compressible and incompressible flows in fluid-structure interaction. This work shows that on increasingly small time intervals, the added mass of a compressible flow is proportional to the length of the time interval, whereas the added mass of an incompressible flow approaches a constant. The paper then presents the implications of this difference on the stability and accuracy of loosely coupled staggered time-integration methods.

The paper by Hauke and Fuster presents a variational multiscale a posteriori error estimation method that is based on approximating an exact representation of the error based on fine-scale Green's function.

Kannan and Masud present two stabilized formulations for the Schrödinger wave equation. One is based on Galerkin/Least-squares ideas and the second one is based on the Variational Multiscale ideas. Using the generalized Kronig–Penney problem they present numerical convergence studies to demonstrate the accuracy and convergence properties of the two methods.

The papers presented in this special volume represent some of the recent advances in the stabilized and multiscale finite element methods and their application to a variety of problems. Lastly, we are very grateful to those who have contributed to the success of this special issue.

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