OPTIMAL CONTROL OF LINEARIZED COMPRESSIBLE NAVIER–STOKES EQUATIONS

Shirshendu Chowdhury[1] and Mythily Ramaswamy[1]

Abstract. We study an optimal boundary control problem for the two dimensional unsteady linearized compressible Navier–Stokes equations in a rectangle. The control acts through the Dirichlet boundary condition. We first establish the existence and uniqueness of the solution for the two-dimensional unsteady linearized compressible Navier–Stokes equations in a rectangle with inhomogeneous Dirichlet boundary data, not necessarily smooth. Then, we prove the existence and uniqueness of the optimal solution over the control set. Finally we derive an optimality system from which the optimal solution can be determined.

1. Introduction

The Navier–Stokes equations for a viscous compressible isentropic fluid in $\Omega \subset \mathbb{R}^N$ is

$$\left.\begin{aligned}
\frac{\partial \rho}{\partial t}(t,x) + \text{div}[\rho(t,x)\boldsymbol{v}(t,x)] &= 0, \\
\rho(t,x)\left[\frac{\partial \boldsymbol{v}}{\partial t}(t,x) + (\boldsymbol{v}(t,x)\cdot\nabla)\boldsymbol{v}(t,x)\right] &= -\nabla p(t,x) + \mu\triangle\boldsymbol{v}(t,x) + (\lambda+\mu)\nabla[\text{div } \boldsymbol{v}(t,x)], \\
p(t,x) &= a\rho^\gamma(t,x), \quad t>0, \ x \in \Omega,
\end{aligned}\right\} \tag{1.1}$$

where $\rho(t,x)$ is the density of the fluid, $\boldsymbol{v}(t,x) = (v_1(t,x),\ldots,v_N(t,x))$ denotes the velocity vector in $\mathbb{R}^N$ and $p(t,x)$ denotes the pressure. Note that the second equation of (1.1) componentwise is

$$\rho\left(\frac{\partial v_i}{\partial t} + \boldsymbol{v}\cdot\nabla v_i\right) = -\frac{\partial p}{\partial x_i} + \mu\triangle v_i + (\lambda+\mu)\frac{\partial}{\partial x_i}[\text{div } \boldsymbol{v}], i=1,2,\ldots,N.$$

Throughout this paper, we follow this same notational convention and use bold script to denote vectors and product spaces. The viscosity coefficients μ, λ are assumed to be constant satisfying the following thermodynamic restrictions: $\mu > 0$, $\lambda + \mu \geq 0$ and the constants $a > 0$, $\gamma > 1$.

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infrastructure cluster computing parallel and distributed computing and computational linear and non linear algebra

Thermal Convection Marcello Lappa,2009-11-05 Thermal Convection Patterns Stages of Evolution and Stability Behavior provides the reader with an ensemble picture of the subject illustrating the state of the art and providing the researchers from universities and industry with a basis on which they are able to estimate the possible impact of a variety of parameters Unlike earlier books on the subject the heavy mathematical background underlying and governing the behaviors illustrated in the text are kept to a minimum The text clarifies some still unresolved controversies pertaining to the physical nature of the dominating driving force responsible for asymmetric oscillatory convection in various natural phenomena and or technologically important processes and can help researchers in elaborating and validating new more complex models in accelerating the current trend towards predictable and reproducible natural phenomena and in establishing an adequate scientific foundation to industrial processes Thermal Convection Patterns Stages of Evolution and Stability Behavior is intended as a useful reference guide for specialists in disciplines such as the metallurgy and foundry field and researchers and scientists who are now coordinating their efforts to improve the quality of semiconductor or macromolecular crystals The text may also be of use to organic chemists and materials scientists atmosphere and planetary physicists as well as an advanced level text for students taking part in courses on the physics of fluids fluid mechanics the behavior and evolution of non linear systems environmental phenomena and materials engineering   *Flow Simulation with High-Performance Computers II* Ernst Heinrich Hirschel,2013-04-17 Der Band enth lt den Abschlu bericht des DFG Schwerpunktprogramms Flu simulation mit H chstleistungsrechnern Es f hrt die Arbeiten fort die schon als Band 38 in der Reihe Notes on Numerical Fluid Mechanics erschienen sind Work is reported which was sponsored by the Deutsche Forschungsgemeinschaft from 1993 to 1995 Scientists from numerical mathematics fluid mechanics aerodynamics and turbomachinery present their work on flow simulation with massively parallel systems on the direct and large eddy simulation of turbulence and on mathematical foundations general solution techniques and applications Results are reported from benchmark computations of laminar flow around a cylinder in which seventeen groups participated   **Riemann Solvers and Numerical Methods for Fluid Dynamics** Eleuterio F. Toro,2013-04-17 High resolution upwind and centered methods are today a mature generation of computational techniques applicable to a wide range of engineering and scientific disciplines Computational Fluid Dynamics CFD being the most prominent up to now This textbook gives a comprehensive coherent and practical presentation of this class of techniques The book is designed to provide readers with an understanding of the basic concepts some of the underlying theory the ability to critically use the current research papers on the subject and above all with the required information for the practical implementation of the methods Applications include compressible steady unsteady reactive viscous non viscous and free surface flows   *Handbook of Fluid Dynamics* Richard W. Johnson,2016-04-06 Handbook of Fluid Dynamics offers balanced coverage of the three traditional areas of fluid dynamics theoretical computational and

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and F Saleri The original lecture notes were also revised and updated

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Table of Contents Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113

1. Understanding the eBook Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113
    - The Rise of Digital Reading Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113
    - Advantages of eBooks Over Traditional Books
2. Identifying Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113
    - User-Friendly Interface
4. Exploring eBook Recommendations from Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113
    - Personalized Recommendations
    - Numerical Solution Of The Incomprebible Navierstokes Equations Vol 113 User Reviews and Ratings

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