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Book of Abstracts - Extract
2015

UNIVERSITÀ DEL SALENTO

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Scientific Program - Timetable

Sunday 22	Time	Monday 23	Tuesday 24	Wednesday 25	Thursday 26	Friday 27
	9: 15 30 45		Contributed sessions (15 in parallel)	Plenary Lecture Moritz Diehl	Contributed sessions (15 in parallel)	Contributed sessions (14 in parallel)
	10: 15 30 45	Registration		von Mises prize lecture		
	11: 15		Coffee Break	Coffee Break	Coffee Break	Coffee Break
	11: 30 45		Plenary Lecture Thomas Böhlke	General Assembly	Plenary Lecture Ferdinando Auricchio	Contributed sessions (11 in parallel)
	12: 15 30 45		Lunch	Lunch	Lunch	
	13: 15	Opening				
	13: 30 45	Univ. Chorus Performance				Closing
	14: 15 30 45	Prandtl Lecture Keith Moffatt	Plenary Lecture Enrique Zuazua	Contributed sessions (15 in parallel)	Plenary Lecture Daniel Kressner	
	15: 15 30 45	Plenary Lecture Giovanni Galdi	Plenary Lecture Nikolaus Adams		Plenary Lecture Stanislaw Stupkiewicz	
Registration pre-opening	16: 15	Coffee Break	Coffee Break Poster session	Coffee Break	Coffee Break Poster session	
	16: 30 45	Minisymposia & Young Reseachers' Minisymposia (10 in parallel)	Contributed sessions (14 in parallel)	Contributed sessions (15 in parallel)	Contributed sessions (15 in parallel)	
	17: 15 30 45					
	18: 15 30 45		Public lecture Francesco D'Andria			
	19: 15 30 45	Opening reception at Castle of Charles V				
	20: 15 30 45					
	21: 15 30 45			Conference dinner at Hotel Tiziano		

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YRMS1: Analysis, Applications and Approximation of Constrained PDEs

A common and convenient way to model multi-component phenomena is to model the components separately and to glue them together via coupling the variables at the interfaces. This approach, however, leads to constrained PDEs that are more often referred to as abstract DAEs or PDAEs and that require sophisticated methods for their numerical and analytical treatment.

The speakers of our minisymposium reflect the broad application area of constrained PDEs and discuss difficulties in the application side and recent advances in the analysis and the numerical approximation. The particular talks will cover general theoretical aspects and applications in the modeling of elastodynamics, electromagnetics, flow networks, and fluid dynamics.

Stable and efficient simulation of hyperbolic PDAEs describing flow networks

Christoph Huck[1], Lennart Jansen[2], Caren Tischendorf[1]
[1]Humboldt-University of Berlin,
[2]Heinrich-Heine-University Düsseldorf

We consider partial differential algebraic equation systems (PDAEs) that consist of hyperbolic PDEs of the type

$$\begin{aligned} p_t + Aq_x &= 0 \\ q_t + Bp_x + G(q)q + H &= 0 \end{aligned}$$

and are coupled via algebraic boundary conditions. Such systems appear in the modeling of flow networks as e.g. water or gas supplying networks [1]. For our simulation approach we use the method of lines, yielding a differential algebraic equation (DAE) which is adaptively discretized in time.

We present a perturbation analysis for a simple prototype for different variants of space discretizations. In particular we show that the index of the resulting DAEs may depend on the chosen space discretization.

Additionally, we present a network topology dependent space discretization guaranteeing DAEs of index 1. Furthermore we study a network topological procedure to reduce the resulting DAEs into semi-explicit systems of the form

$$\begin{aligned} x' &= f(x,t) \\ y &= Mx + r(t). \end{aligned}$$

that can be exploited for more efficient simulations, e.g. by use of model order reduction or exponential integrators.

References

[1] L. Jansen, C. Tischendorf. A unified (P)DAE modeling approach for flow networks. In Progress in Differential-Algebraic Equations. Differential-Algebraic Equations Forum, 127-151. Springer Berlin Heidelberg, 2014.

Stochastic Modeling and Regularity of the Nonlinear Elliptic-Parabolic Magnetoquasistatic Equation

Ulrich Römer, Sebastian Schöps
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Graduate School of Computational Engineering, Technische Universitaet Darmstadt

Simulation predictions with increased reliability can be realized by taking into account uncertainties in the inputs of mathematical models. In this contribution we are concerned with the nonlinear elliptic-parabolic magnetoquasistatic equation

$$\sigma \partial_t \vec{A} + \nabla \times \Big(\nu(|\nabla \times \vec{A}|) \nabla \times \vec{A} \Big) = \vec{J}, \tag{1}$$

with uncertainties, where $\vec{A}$ and $\vec{J}$ represent the magnetic vector potential and source current density, respectively. This model, which is important for magnetic devices such as electrical machines or magnets, is elliptic in the non-conducting air part and parabolic in the conducting iron part. Its numerical approximation by the finite element method leads to a system of differential-algebraic equations [1] of index one or possibly higher for a coupling to external circuits. Here, we are concerned with uncertainties in the material properties ν expressing the magnetic iron properties. To this end a stochastic/parametric model is proposed and analyzed. In particular we discuss the modeling of randomness in ν in the presence of a monotonicity constraint. Also an efficient spline-based discretization of the random input by the Karhunen-Loève expansion is presented. The stochastic model has a high-dimensional deterministic counter-part

$$\sigma \partial_t \vec{A}(\vec{y}) + \nabla \times \Big(\nu(\vec{y}, |\nabla \times \vec{A}(\vec{y})|) \nabla \times \vec{A}(\vec{y}) \Big) = \vec{J}, \tag{2}$$

with parameter vector $\vec{y} \in \Gamma \subset \mathbb{R}^M$. Its efficient numerical approximation is a challenging task. A particularly appealing method is based on stochastic collocation [2] as it features a rapid convergence rate and results in the repetitive solution of deterministic problems. Although this technique is well-established in practice, a priori estimates of the collocation error of system (1) are the subject of ongoing work. Starting from a regularity analysis for the uncoupled elliptic system [3] yielding an algebraic convergence rate of p^{-k} for tensor product collocation of polynomial degree p, possible extensions to the case of a field-circuit coupling and to the time-transient case will be addressed. The result is confirmed by academic and engineering benchmark examples.

References

[1] A. Nicolet, F. Delincé. Implicit Runge-Kutta Methods for Transient Magnetic Field Computation. IEEE Transactions on Magnetics 32 (1996), 1405-1408.

[2] I. Babuška, F. Nobile, and R. Tempone. A stochastic collocation method for elliptic partial differential equations with random input data. SIAM review 52 (2010), 317-355.

[3] U. Römer, S. Schöps, and T. Weiland. Stochastic Modeling and Regularity of the Nonlinear Elliptic curl-curl Equation. Submitted manuscript.

Hydrodynamic force elements: A PDAE approach

Robert Fiedler, Martin Arnold
Martin-Luther-University Halle-Wittenberg

The simulation of mechanical systems results often in multi-component phenomena with different time scales or different solution strategies which influence each others problem characteristics. In our case we have a flexible multibody system coupled with special force elements. The modelling of elastohydrodynamic bearings in combustion engines leads to a coupled system of partial differential algebraic equations, which is represented by a flexible multibody system model of crankshaft and bearing and by the Reynolds equation that describes the non-linear effects in the fluid film. The hydrodynamic forces depend strongly on the position and the elastic deformation of crankshaft and bearing shell therefore a fine spatial discretisation is needed.

The influence of the spatial discretisation on accuracy and numerical effort will be discussed. Since a fine one substantially slows down the numerical solution, we propose an asymptotic analysis with methods from singular perturbation theory to speed-up time integration. The interplay of this semi-analytical approach with index reduction techniques for the multibody part is studied for the fourbar test problem.

Numerical tests for a realistic benchmark problem illustrate the advantages of this approach.

The Pressure Manifold in the Unsteady Navier-Stokes Equation and in Semi-Discretizations

Jan Heiland
Max-Planck Institute for Complex Dynamical Systems Magdeburg, Germany

The right treatment of the pressure p is key in stable approximation schemes for time dependent Navier-Stokes equations.

$$\dot{v} + (v \cdot \nabla)v + \nabla p - \nu \Delta v = f, \tag{1a}$$
$$\operatorname{div} v = 0, \quad \text{in } \Omega \times (0, T). \tag{1b}$$

A discrete approximation to (1) is typically given as

$$M\dot{v}_k - A(v_k) - J_k^{\mathsf{T}} p_k = f_k, \tag{2a}$$
$$J_k v_k = 0, \quad \text{in } (0, T), \tag{2b}$$

i.e. the spatial component in (1) is discretized by approximating $v(t)$ and $p(t)$ via finite-dimensional vectors $v_k(t)$ and $p_k(t)$,

Commonly used methods like *projection* or *pressure correction* schemes for the time discretization of (2) base on the repeated solution of the so called *Pressure Poisson Equation*:

$$-J_k M^{-1} J_k^{\mathsf{T}} p_k = J_k M^{-1} f + J_k M^{-1} A(v_k). \tag{3}$$

For stable discretization schemes, the discrete *Pressure Poisson Equation* is well defined for (2), which may not be the case for the corresponding continuous equation (1).

In my talk, I will discuss a decoupling of the Navier-Stokes equations by means of a continuous *Pressure Poisson Equation* that is in line with the schemes for the semi-discrete approximations.