Preface

The 8th Workshop on Coupled Descriptor Systems took place on March 4–7, 2013 in the Castle of Eringerfeld, Geseke, in the neighborhood of Paderborn, Germany. Following the tradition of the seven preceding workshops organized by Prof. Peter C. Müller between 1992 and 2005, the workshop brought together more than 30 mathematicians and engineers from various fields, e.g., mechanics and electromagnetic theory. The participants focused on the theoretical and numerical treatment of coupled and multiphysical 'descriptor' systems of differential-algebraic equations.

This book contains the proceedings of this workshop. It examines the wide range of current research topics in descriptor systems, including mathematical modeling, index analysis, wellposedness of problems, stiffness and different timescales, cosimulation and splitting methods and convergence analysis. In addition, it also presents applications from the automotive and circuit industries that show that descriptor systems are still challenging problems from the point of view of theory and practice.

This book is organized into three parts with the first covering **Control**. It features a contribution by Peter C. Müller that discusses *Lyapunov Matrix Equations for the Stability Analysis of Linear Time-Invariant Descriptor Systems*. In it, he compares two different generalizations of the classical Lyapunov matrix equation in theory and in the application to mechanical descriptor systems. This part also includes a contribution by Thomas Berger entitled *Zero Dynamics and Stabilization for Linear DAEs* which is devoted to the study of linear differential-algebraic multi-input multi-output systems. In it, the author introduces the concepts of autonomous zero dynamics, transmission zeros, right-invertibility, stabilizability in the behavioral sense and detectability in the behavioral sense and also derives algebraic characterizations. Also in this part, Daniel Labisch and Ulrich Konigorski introduce new necessary and sufficient conditions for causal observability of nonlinear descriptor systems and present a method to design the causal observer. The approach is based on the transformation of the descriptor system into a state space form.

The second part of this book covers **Simulation** and consists of three contributions: the first contribution *Monitoring Singularities While Integrating DAEs* is

by Diana Estévez Schwarz and René Lamour. It presents an approach that allows (higher) index determination during runtime by using automatic (or algorithmic) differentiation. This part also includes two contributions by Martin Arnold. His first article entitled *Modular Time Integration of Block-Structured Coupled Systems Without Algebraic Loops* offers an introduction to the mathematical challenges of cooperative simulation (co-simulation). In his second article *Efficient Time Integration of Block-Structured Descriptor Systems*, Arnold and his co-workers discuss recent results, which were also presented within a keynote lecture at Eringerfeld. This second article has been previously published in the *Archive of Mechanical Engineering* LX(2013) 75–94 (DOI: 10.2478/meceng-2013-0005) and it is reproduced in the present proceedings volume with kind permission of the Polish Academy of Sciences. The last contribution in this part is the work of Lennart Jansen and Caren Tischendorf entitled *A Unified (P)DAE Modeling Approach for Flow Networks*. In it, the authors present a modeling framework for the various types of flow networks, e.g., electric circuits but also water and gas supplying networks in the context of differential-algebraic equations.

The third and final part includes two contributions with a strong focus on **Model Order Reduction**. Nicodemus Banagaaya and Wil H. A. Schilders present a new model-order reduction method for DAEs, which reduces differential-algebraic equations while preserving the index of the system. This paper features examples from circuit simulation. In addition, Sara Grundel and co-workers investigate *Model Order Reduction of Differential Algebraic Equations Arising from the Simulation of Gas Transport Networks*. This paper explores the tractability index of the system and proposes tailored model order reduction techniques.

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