

Preface

Multibody dynamics comprises industrial design of road and railway vehicles, of robots, and of air- and spacecrafts. Further applications are biomechanics and dynamics of machinery. In these fields, numerical simulation has become a key technology that is in a steady process of developing new methods in order to cope with the growing complexity of today's models. The construction of new algorithms and the implementation of the corresponding software require interdisciplinary research both in numerical analysis and mechanical engineering, and therefore the exchange of research results and the collaboration between academic and industrial research groups are essential.

To provide a forum for this exchange, the workshop *Numerical Methods in Multibody Dynamics* took place in October 2001 at the small town of Bad Herrenalb in the Black Forest, Germany. The workshop was supported by ECMI, the European Consortium on Mathematics for Industry, and organised by the so-called Special Interest Group Multibody Dynamics of ECMI. With participants from Germany, Italy and Sweden representing academia, research labs, and industry, the workshop covered various aspects of multibody dynamics and led to an exchange of ideas and an improved collaboration.

This issue contains seven selected papers that were presented at the workshop. The first contribution by A. Schiela and F. Bornemann, *Sparsing in Real Time Simulation*, deals with the real time simulation of stiff equations of motion. Using sparsing techniques, the authors introduce an algorithm that determines those parts of the Jacobian that are relevant for the stability of semi-implicit time integration schemes. In the second contribution *Dynamic Modeling in the Simulation, Optimization, and Control of Bipedal and Quadrupedal Robots* by M. Hardt and O. von Stryk, the nonlinear dynamics of legged robot motion is investigated. More specifically, a numerical optimal control method and new stability and energy performance indices are presented which are well-suited for the generation of fast walking or even running motions.

Flexible multibody dynamics is the subject of the following two contributions. First, M. Borri, C. L. Bottasso, and L. Trainelli present *An Invariant-Preserving Approach to Robust Finite-Element Multibody Simulation*. They describe the main concepts that have inspired a novel approach for the integration of general non-linear structural and multibody dynamics problems within a finite-element framework that includes geometrically exact beams. Second, J. Díaz and C. Führer introduce *A Wavelet Semidiscretisation of Elastic Multibody Systems* that is based on a Galerkin-wavelet method and aims at a reasonably small number of elastic modes.

The final three contributions show the variety of challenging problems and solution techniques in multibody systems. Th. Stoßmeister analyses *Integration through Singularities* and demonstrates how the position constraint equations can be blown up to avoid models with singularities in certain configurations. Next, M. Gerds is concerned with *Optimal Control and Real Time Optimization of Mechanical Multibody Systems*, an approach that combines sensitivity analysis with the discretization of differential-algebraic equations (DAEs) of index 3. Last but not least, the paper *Blended Lobatto Methods in Multibody Dynamics* by M. Schaub and B. Simeon discusses a class of integration schemes that offers the possibility to adapt the numerical damping and asymptotic behaviour to the given tolerance and the stiffness of the multibody system.

At this point, we would like to thank all the authors who contributed to this issue. We hope that their work demonstrates the importance of the subject but also serves as starting point for future research.

Martin Arnold, Claus Führer, Bernd Simeon