Preface

Starting with the research of G. Bögelsack in the 1970s, the analysis of biological locomotion and manipulation systems and their technical realization has been an important research field within the Faculty of Mechanical Engineering at the Ilmenau University of Technology. In 1996, the German Research Foundation (DFG) funded the Innovation College "Motion Systems" at the University of Jena in a cooperation with engineers at the Ilmenau University of Technology. Thus, research was able to be intensified and extended. Of course, the whole spectrum of biologically inspired systems is much too wide, so the analysis was still focused on locomotion and manipulation systems.

At this stage J. Steigenberger from the Faculty of Mathematics and Natural Sciences at the Ilmenau University of Technology contributed important studies of worm-like locomotion systems with much dedication and technical competence. Moreover, he conceived and carried out a lecture series entitled "Mathematical Basics for Locomotion Systems", which was based on his evaluation of national and international research developments in this field. I. Zeidis and K. Zimmermann contributed many publications on the mechanics of worm-like locomotion systems based on continuum and rigid-body models as well as asymptotic methods.

Since 2004 the German Research Foundation has supported a series of projects led by K. Zimmermann dedicated to biologically inspired robotics. In addition to these activities, the Department of Technical Mechanics and the Department of Computer Application in Mechanical Engineering (M. Weiß) together with masters and doctoral students started the development of mobile robots for the RoboCup Small-Size League in 1998.

On the basis of these teaching and research activities, the idea for a manuscript about the mechanics of terrestrial locomotion was born, despite knowing full well that there are no "new" mechanics to be developed for such systems. Rather, specific aspects of mechanics and control theory that are applied in terrestrial locomotion systems were to be prepared methodically in textbook style to be used by students. Exercises for self-study are provided in addition to the theoretical basics.

This textbook is mainly aimed at undergraduate students in mechanical engineering, electrical engineering, automation engineering, and mechatronics, but should also be of interest to graduates in engineering, mathematics, or computer science looking for an introduction to the field of mobile robotics from the mechanical point of view. To keep the book self-contained, we summarize some fundamental results and principles from mechanics and control theory that are needed later on in the first two chapters. We decided to keep the mathematical tools used in the book to a level that is digestible for an engineering undergraduate and only require some familiarity with undergraduate linear algebra, elementary differential and integral calculus and vector calculus. In particular, we do not include functional-analytic or differential-geometric considerations in this book. The authors refer the reader to the excellent books *A Mathematical Introduction to Robotic Manipulation* by R. Murray et al., and *Geometric Control of Mechanical Systems* by F. Bullo & A.D. Lewis for these advanced topics.

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With a Focus on Non-pedal Motion Systems

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