Preface

This monograph presents the configuration space method for computer-aided design of mechanisms with changing contacts of parts. Configuration space is a complete and compact geometric representation of the motions and interactions of parts in a mechanism that supports the core design tasks of analysis, synthesis, and tolerancing. Our method is the first general algorithmic treatment of the kinematics of higher pairs with changing contacts. It helps designers detect and correct unexpected kinematic behaviors and design flaws, as demonstrated in automotive, micromechanical, and optical case studies.

This book is intended for students, researchers, and engineers in mechanical engineering, computer-aided design, computer science, and robotics. The presentation is self-contained and is suited for a course, a seminar, or independent study. The prerequisites are freshman mathematics and computer science.

The first part describes the configuration space framework and the algorithms for the kinematics of mechanisms. The second part describes the algorithms for kinematic analysis, tolerancing, and synthesis based on configuration spaces. The third part presents four case studies taken from industry in which the configuration space method supports the analysis and design of mechanisms. A catalog of higher-pair mechanisms is given in appendix A. Appendix B describes an open-source C++ mechanical design system, called HIPAIR, that implements some of the configuration space methods described in this book, including visualization of configuration space and kinematic simulation. HIPAIR comes with an interactive graphical user interface and many sample input files for mechanisms.