Foreword

At the dawn of the new millennium, robotics is undergoing a major transformation in scope and dimension. From a largely dominant industrial focus, robotics is rapidly expanding into the challenges of unstructured environments. Interacting with, assisting, serving, and exploring with humans, the emerging robots will increasingly touch people and their lives.

The goal of the new series of Springer Tracts in Advanced Robotics (STAR) is to bring, in a timely fashion, the latest advances and developments in robotics on the basis of their significance and quality. It is our hope that the wider dissemination of research developments will stimulate more exchanges and collaborations among the research community and contribute to further advancement of this rapidly growing field.

The monograph written by Woojin Chung is an evolution of the Author's Ph.D. dissertation. The work builds upon an increasing interest in nonholomic mechanical systems which have attracted several researchers in control and robotics. A key feature of the work is the possibility to exploit nonholonomic theory to design innovative mechanical systems with a reduced number of actuators without reducing the size of their controllable space. The volume offers a comprehensive treatment of the problem from the theoretical development of the various control schemes to prototyping new types of manipulators, while testing their performance by simulation and experiments in a number of significant cases.

One of the first focused books on nonholomic manipulators, this title constitutes a fine addition to the series!

Naples, Italy
April 2004

Bruno Siciliano
STAR Editor

Preface

Recently the nonholonomic mechanical systems have received much attention in the field of robotics and control engineering. The scope of this book is about the definitions and developments of new nonholonomic machines which are designed on the basis of nonlinear control theory for nonholonomic mechanical systems. So far, many useful research achievements had been accumulated for the kinematic analysis and development of control schemes for driftless nonholonomic systems. Control theoretic strategies based on the differential geometric framework have achieved remarkable progresses. However, previous works on the nonholonomic mechanical systems have been carried out mainly focusing on the development of control strategies for known existing nonholonomic machines.

The starting point of this book is to explore the possibility of innovative and useful mechanisms from the nonlinear control theoretic background. While previous publications have assumed the nonholonomic systems to have given and developed theory for these systems, this book points out a new direction where the nonholonomic theory is used to design controllable systems.

The specific goal of this study is to design and to control a manipulator which consists of n revolute joints using only two actuators, by exploiting the unique feature of nonholonomic systems. This fact will cause a revolutionary change in mechanical design, especially, when it is essential to reduce the number of actuators without reducing the dimension of the reachable configuration space.

This book is based on my Ph.D. dissertation written under the supervision of Professor Yoshihiko Nakamura at Department of Mechano-Informatics, the University of Tokyo. Professor Nakamura has inspired me to do my best. My personal development have benefited immensely from not only his scholarly attitude to research, but also his own enthusiastic manner to life.

I would like to thank Professor Ken-ichi Yoshimoto, who was in charge of Mechanisms and Control Laboratory, for guiding me through research efforts and fruitful discussions.

I would like to thank Doctor Ole Jacob Sørdalen for the part of this book, for leading me to interesting nonholonomic world and valuable comments and advices. I acknowledge Doctor Tetsuro Yabuta, Doctor Ken Tsujimura in NTT Co., Ltd., and Mr. Kazuhusa Noda, Mr. Osamu Muraki in Oshima Prototype Engineering Co., Ltd. for their supports and collaboration in building the prototypes. I gratefully acknowledge POSCO Scholarship Society for their financial support and good service during my stay in Japan.

I am very grateful to the research staffs and students of the Mechanisms and Control Laboratory in University of Tokyo. I am specially grateful to Hideaki Ezaki for his great contribution in building an experimental setup. I would like to thank colleagues and students at the Intelligent Robotics Research Center, Korea Institute of Science and Technology.

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Finally, I am very grateful to my parents for their encouragement and support throughout my life, and especially to my wife Yoola Shin, who is always a friendly partner.

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