

# Springer Tracts in Advanced Robotics

## Volume 7

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Editors: Bruno Siciliano · Oussama Khatib · Frans Groen

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J.-D. Boissonnat • J. Burdick • K. Goldberg • S. Hutchinson (Eds.)

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# **Algorithmic Foundations of Robotics V**

With 226 Figures



**Springer**

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# 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.

Since its inception about a decade ago, WAFR, the *Workshop on Algorithmic Foundations of Robotics* has published archival volumes of high reference value. With the launching of STAR, a more suitable home is found for this and other thematic symposia devoted to excellence in robotics research.

The Fifth edition of *Algorithmic Foundations of Robotics* edited by Jean-Daniel Boissonnat, Joel Burdick, Ken Goldberg and Seth Hutchinson offers in its nine-chapter volume a collection of a broad range of topics in advanced robotics. The contents of these contributions represent a cross-section of the current state of robotics research from one particular aspect: algorithms, and how they reflect on the theoretical basis of subsequent developments. Validation of algorithms, design concepts, or techniques is the common thread running through this focused collection.

Rich by topics and authoritative contributors, WAFR culminates with this unique reference on the current developments and new directions in the field of algorithmic foundations. A fine addition to the series!

Naples, Italy  
May 2003

Bruno Siciliano  
STAR Editor

# Preface

Robot algorithms are abstractions of computational processes that control or reason about motion and perception in the physical world. Because actions in the physical world are subject to physical laws and geometric constraints, the design and analysis of robot algorithms raises fundamental questions in computer science, computational geometry, mechanical modelling, operations research, control theory, and associated fields. The biannual Workshop on the Algorithmic Foundations of Robotics was established in 1994 as a single-track meeting to focus on algorithmic issues related to robotics and automation.

The Fifth international Workshop on the Algorithmic Foundations of Robotics was held from 15–17 December 2002 at the Westminster Hotel in Nice, France. Approximately sixty international researchers participated. Two plenary talks were presented: Algorithms for Motion and Navigation in Virtual Environments and Games, by Mark Overmars of Utrecht University, and Surgery Simulation: Integrating Geometry, Physics and Physiology into the Virtual Patient, by Nicholas Ayache of INRIA.

The highly selective program highlighted significant new results in probabilistic and sampling-based path planning, modelling of knots, reconfigurable robots, coordination of multiple robots, distributed manipulation, graphics and visualization, molecular modeling, and mobile robotics. Thirty-three papers presented at WAFR 2002 are collected in the present volume.

In addition to the editors of this volume, the Program Committee for WAFR 2002 included: Pankaj Agarwal, Nancy Amato, Nicholas Ayache, Antonio Bicchi, Robert-Paul Berretty, Karl Bohringer, Howie Choset, Leonidas J. Guibas, Kamal Gupta, Dan Halperin, Hirohisa Hirukawa, Makoto Kaneko, Lydia Kavraki, Jean-Paul Laumond, Matt Mason, Joe Mitchell, Dinesh Pai, Jean Ponce, and Frank van der Stappen.

As the co-chairs of WAFR 2002, we are grateful to Jean-Claude Latombe and the past WAFR organizers for their leadership and guidance. We also wish to thank Bruno Siciliano for encouraging us to publish this volume with Springer-Verlag, and Thomas Ditzinger of Springer. We also thank Terry Peterson for her efforts in collecting and formatting the text, Dany Sergeant and Agnes Clement-Bessiere for their help with local arrangements, Kevin Clarke for poster design, and INRIA for additional financial support.

Finally, our thanks to all of the participants and authors for their enthusiasm in making WAFR 2002 such a lively research meeting.

Nice, France  
December 2002

Jean-Daniel Boissonnat  
Joel Burdick  
Ken Goldberg  
Seth Hutchinson

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