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Oussama Khatib, Vijay Kumar,
Daniela Rus (Eds.)

# Experimental Robotics

## The 10th International Symposium on Experimental Robotics

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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, wanted by my STAR Co-Editor Oussama Khatib some twenty years ago, the *International Symposium on Experimental Robotics* (ISER) was published by Springer. Since the two past editions, ISER has found a more suitable home under STAR, together with other thematic symposia devoted to excellence in robotics research.

The Tenth edition of *Experimental Robotics* edited by Oussama Khatib, Vijay Kumar and Daniela Rus offers in its 53-chapter volume a collection of a broad range of topics in field and human-centered robotics. The contents of these contributions represent a cross-section of the current state of robotics research from one particular aspect: experimental work, and how it reflects on the theoretical basis of subsequent developments. Experimental validation of algorithms, design concepts, or techniques is the common thread running through this large collection of widely diverse contributions, spanning from manipulation to vision, from design to control, from navigation and localization to estimation.

From its warm social program to its excellent technical program including a retrospective panel discussion, ISER culminates with this unique reference on the current developments and new directions in the field of experimental robotics – “keep the gradient” ;-)

Naples, Italy
July 2007

Bruno Siciliano
STAR Editor

# Preface

The International Symposium on Experimental Robotics (ISER) is a series of biennial symposia whose goal is to provide the robotics community with a forum for research focused on novel ideas, visions, systems, and applications of robotics, for works with strong experimental validation of theory. These symposia highlight projects in which experimental validation is a critical component of the research, and experimentation derives the development of new theoretical results. This year's meeting was conceived to bring together in a small group setting researchers from around the world who are at the forefront of experimental robotics research, to discuss current results and new directions for the field. The meeting was organized around oral technical presentations.

The Tenth Symposium was held in Rio de Janeiro, Brazil, between July 6-12 2006. The symposium was chaired by Oussama Khatib (Stanford University, USA), Vijay Kumar (University of Pennsylvania, USA), Daniela Rus (Massachusetts Institute of Technology, USA). The local organizing committee consisted of Mario Campos (Universidade Federal de Minas Gerais, Brazil), Luiz Chaimowics, (Universidade Federal de Minas Gerais, Brazil), and Guilherme Pereira, (Universidade Federal de Minas Gerais, Brazil. The International Steering Committee for ISER is chaired by Oussama Khatib and includes Marcelo Ang (Singapore), Herman Bruyninckx (Belgium), Alicia Casals (Spain), Raja Chatila (France), Peter Corke (Australia), Eve Coste-Maniere (France), John Craig (USA), Paolo Dario (USA), Vincent Hayward (Canada), Gerd Hirzinger (Germany), Yoshihiko Nakamura (Japan), Daniela Rus (USA), Kenneth Salisbury (USA), Bruno Siciliano (Italy), Sanjiv Singh(USA), James Trevelyan (Australia), Tsuneo Yoshikawa (Japan), and Alex Zelinsky (Australia).

The program included technical papers reporting on new theoretical and experimental results, as well as position papers focused on new visions and trends for the field. The topics of the technical sessions covered a broad spectrum of experimental robotics research activities. The sessions were on manipulation, vision, navigation, medical and bio-robotics, estimation and mapping, field robotics, estimation and control, estimation and localization, design, cooperative control, and humanoids.

This year's symposium brought a retrospective panel entitled "20 Years of Experimental Robotics," which was organized to celebrate the 10th anniversary of ISER and to discuss the key developments in the field over the past two decades. The panel was

chaired by Bernie Roth (Stanford) and the panelists were Harry Asada (MIT, USA), Peter Corke (CSIRO, Australia), Eve Coste-Maniere (France), Bradley Nelson (ETH, Switzerland), and Alex Zelinsky (CSIRO, Australia). The panelists gave overviews of how different aspects of experimental robotics evolved and highlighted the technologies we take for granted today that did not exist twenty years ago, what did not change, and what should change.

The technical part of the meeting culminated with a surprise special session featuring a collage of images from previous meetings compiled by Eve Coste-Maniere. This retrospective showed wonderful, moving, and sometimes funny snapshots from the 20-year life of ISER. At the end of this session a special award (the Toucan D'Or) was presented to Oussama Khatib for his tireless passion to ensure each of the past 10 meetings we perfect, and a toast was made to the next twenty years of experimental robotics.

The papers in this volume bring the most up-to-date and exciting results in experimental robotics. They capture the enthusiasm and passion of the ISER 2006 community, who left Rio, inspired to make even faster progress towards making robotics pervasive in industrial, home, and field applications, paving the way from personal computers to personal robots.

We are grateful to the authors, panelists, and member of the organizing committee, who have all contributed to the success of this symposium by bringing an outstanding program, excellent technical presentations, and stimulating and insightful panel discussion, and productive informal exchanges. We are grateful to the local organizing team for the thoughtfulness with which they blended social events with the technical sessions, to ensure the meeting delegates experienced the best of Rio.

Rio de Janeiro, Brazil
July 11, 2006

Oussama Khatib
Vijay Kumar
Daniela Rus

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