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Volume 21

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**The 9th International Symposium
on Experimental Robotics**

With 332 Figures and 34 Tables

Professor Bruno Siciliano, Dipartimento di Informatica e Sistemistica, Università degli Studi di Napoli Federico II, Via Claudio 21, 80125 Napoli, Italy, email: siciliano@unina.it

Professor Oussama Khatib, Robotics Laboratory, Department of Computer Science, Stanford University, Stanford, CA 94305-9010, USA, email: khatib@cs.stanford.edu

Professor Frans Groen, Department of Computer Science, Universiteit van Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands, email: groen@science.uva.nl

Editors

Dr. Marcelo H. Ang Jr.

National University of Singapore
Department of Mechanical Engineering
9 Engineering Dr 1
Singapore 117576
Singapore

Prof. Oussama Khatib
Stanford University
Robotics Laboratory
Department of Computer Science
Stanford, CA 94305-9010
USA

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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 are increasingly touching 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 some sixteen years ago, the *International Symposium on Experimental Robotics* (ISER) was published by Springer. Since the past edition, ISER has found a more suitable home under STAR, together with other thematic symposia devoted to excellence in robotics research.

The Ninth edition of *Experimental Robotics* edited by Marcelo H. Ang Jr. and Oussama Khatib offers in its fourteen-chapter volume a collection of a broad range of topics in 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.

From its warm social program to its excellent technical program, ISER culminates with this unique reference on the current developments and new directions in the field of experimental robotics – a confirmation for the series!

Naples, Italy
August 2004

Bruno Siciliano
STAR Editor

Preface

The Ninth Edition of Experimental Robotics is proud to present the latest in the cutting edge robotics research. From numerous submission containing high quality research, the review committee was forced to make difficult decisions to come up with a selection of 57 papers – which were presented in the 9th International Symposium on Experimental Robotics (ISER), 18–21 June 2004, Singapore. After the discussions during the Symposium, authors had a chance to revise their papers. This book contains the final version of the papers presented.

ISER is a series of bi-annual meetings which are organized in a rotating fashion around North America, Europe and Asia/Oceania. Previous venues were Montréal (Canada), Toulouse (France), Kyoto (Japan), Stanford (USA), Barcelona (Spain), Sydney (Australia), Honolulu (USA), and Sant'Angelo d'Ischia (Italy). Singapore is proud to host the 9th meeting of this active and prestigious symposium. The goal of ISER is provide a forum for research in robotics that focuses on novelty of theoretical contributions validated by experimental results. The meetings are conceived to bring together, in a small group setting, researchers from around the world who are in the forefront of experimental robotics research. This book presents the latest advances across the various fields of robotics, with ideas that are not only conceived conceptually but also explored experimentally.

This year, we are pleased to have a keynote address by Dr. Larry Matthies of the Jet Propulsion Laboratory which presented the interesting results of the Mars Rover Project. We have also included the keynote in this edition of Experimental Robotics as the *featured article*.

On behalf of the ISER Steering Committee, we would like to acknowledge the sponsorship of the ISER 2004 student fellowships from International Foundation of Robotics Research (IFRR) and Ben Wegbreit, and the support of the Singapore Exhibition and Convention Bureau and Lee Foundation. Most importantly, we would like to thank you for your participation and sharing of your exciting research developments.

Singapore, August 2004

With best regards,
Marcelo H. Ang Jr.
Oussama Khatib
Co-chairs, ISER 2004

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