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Special Issue on the Grand Challenges of Robotics

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Special Issue on the Grand Challenges of Robotics

James Ostrowski, Adriana Tapus, Mark Yim

Inspired by the hugely successful DARPA Grand Challenge, the workshop organizers of the Robotics Science and Systems 2006 (RSS'06) conference decided to use Grand Challenges of Robotics as a theme for the RSS'06 workshops. Besides including the normal presentations of recent developments in a select area of robotics, each workshop was charged with defining the grand challenges for their research areas. This involved identifying the main problems that were still to be resolved, discussing which challenges held the most promise for moving the field forward, and selecting representative challenge tasks or demonstrations that could be used to serve as tests for progress being made toward solving these challenges. Grand challenges such as these can serve as concrete targets for which multiple groups can focus their research efforts in order to make tangible, and measurable, progress.

The workshops and their organizers at the conference were:

- Symbolic Approaches to Robot Motion Planning and Control
  - Calin Belta, Boston University
  - George J. Pappas, University of Pennsylvania
- Robotic Systems for Rehabilitation, Exoskeleton, and Prosthetics
  - Yoky Matsuoka, Carnegie Mellon University
  - Bill Townsend, Barrett Technology, Inc.
- Intuitive Human-Robot Interaction for Getting the Job Done
  - Geert-Jan M. Kruijff, German Research Center for Artificial Intelligence
  - Dirk Spenneberg, German Research Center for Artificial Intelligence
  - Frank Kirchner, German Research Center for Artificial Intelligence
- Science and Technology Challenges for Robotics
  - George Bekey, University of Southern California
  - Vijay Kumar, University of Pennsylvania
  - Matthew Mason, Carnegie Mellon University
- Socially Assistive Robotics
  - Adriana Tapus, University of Southern California
  - Maja Mataric, University of Southern California
- Self-Reconfigurable Modular Robots
  - Mark Moll, USC/ISI
  - Behnam Salemi, USC/ISI
  - Greg Chirikjian, Johns Hopkins University
  - Eric Klavins, University of Washington
  - Hod Lipson, Cornell University
  - Daniela Rus, Massachusetts Institute of Technology
  - Wei-Min Shen, USC/ISI
  - Mark Yim, University of Pennsylvania
- Manipulation for Human Environments
  - Charles C. Kemp, Massachusetts Institute of Technology
  - Aaron Edsinger, Massachusetts Institute of Technology
  - Paul Fitzpatrick, University of Genova
  - Lorenzo Natale, Massachusetts Institute of Technology
  - Torres-Jara, Massachusetts Institute of Technology
- The DARPA Grand Challenge
  - Chris Urmson, Carnegie Mellon University
  - Mike Montemerlo, Stanford University
  - Richard Murray, California Institute of Technology
  - Ron Kurjanowicz, DARPA
  - Stefano Soatto, UCLA
  - Sebastian Thrun, Stanford University
- Grand Challenges of Micro and Nanoscale Robotics
  - Metin Sitti, Carnegie Mellon University
  - Bradley Nelson, ETH Zurich

Details of all the workshops can be found at http://robotics.cs.brown.edu/rss06/workshops.shtml.

Six of the nine workshops are including articles for this special issue.

In developing concrete goals for their fields, some of the discussions, especially for newly emerging areas, led naturally to exploring the definition of the field itself. So, the resulting articles generally 1) define the field or subdiscipline, 2) talk about what is important in the respective field, and 3) present challenges and goals for the future and the promises of what can happen if those challenges are met.

The first article, "Challenges for Robot Manipulation in Human Environments" describes the issues that arise in dealing with robots that manipulate objects in less structured environments, like the home. A special emphasis is placed on examining the constraints that are placed on robotic systems that operate in close proximity to humans. "Prosthetics, Exoskeletons, and Rehabilitation" brings the systems even closer to humans, discussing the challenges of developing robotic applications in intimate contact with humans. And

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"Socially Assistive Robotics," while also dealing with assisting humans, addresses the relatively new concerns of social (rather than physical) interaction of robots with humans. The next two articles move away from human-centered robotics, and focus more on design, assembly, and control of robotic systems. "Modular Self-Reconfigurable Robot Systems" describes the area of robotics where the systems can "morph" themselves into new shapes. This leads to a wide variety of possibilities of robots in many different configurations, shapes, and sizes. As robots get smaller and smaller there are a variety of new capabilities and challenges as presented in the article "Microscale and Nanoscale Robotics Systems." Finally, "Symbolic Planning and Control of Robot Motion" focuses on an emerging area of motion planning and control using tools such as automata, temporal logics, and grammars.

The overview we have captured here is necessarily incomplete—it captures a snapshot of a set of topics currently being worked on in academic robotics research. We hope this series of articles will stimulate further discussion in these topic areas and others, and will serve as a focal point for research in the areas they describe. They also provide a general introduction and overview for interested readers outside of the areas.

Finally, we would like to thank all the authors, reviewers, and workshop participants as well as the National Science Foundation, which partially sponsored the workshops.

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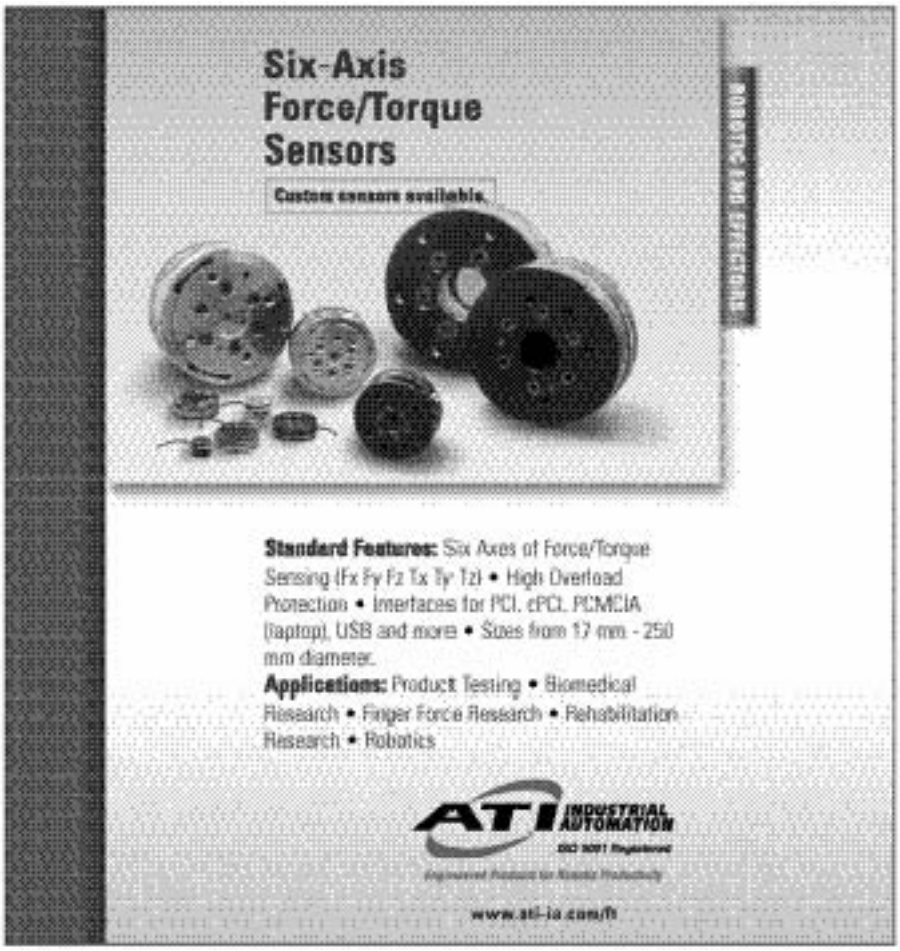
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