

Report on the 2006 IEEE International Conference on Robotics and Automation, Orlando, Florida, 15–19 May 2006

The 2006 IEEE International Conference on Robotics and Automation (ICRA 2006) is now part of the IEEE Robotics and Automation Society (RAS) history. It was held in the great city of Orlando, Florida, and was the culmination of many years of work of the organizing committee. This year, ICRA 2006 continued its technical excellence and celebrated its 23rd anniversary as the internationally recognized premier meeting in the field of robotics and automation with many innovations in the technical program. These innovations include posters, the double-blind review of papers/posters, the afternoon time for the plenary sessions, the program-at-a-glance (an idea of Prof. Kevin Lynch), the shortening of the awards program to an hour, the reorganization of the video sessions, the Best Reviewer awards, the significant reduction of the workshop/tutorial fees, and, of course, the inclusion of giant cookies in the coffee breaks!

Over the last decade, many exciting technologies/algorithms have emerged that improve the mobility, intelligence, adaptability, and interactivity of robotic systems for real-world applications. For example, one should note the research and development of humanoid robots for domestic applications and entertainment, the use of biologically inspired robots for search-and-rescue operations, the various localization schemes, and the exploration in micro-/nanorobotics to investigate microassembly and medical applications. These topics were reflected in the submitted papers to the conference. The conference theme was “Humanitarian Robotics,” a rapidly evolving area with a profound impact on our world. Unfortunately, the response to the conference theme was not as expected, and only a handful of papers was submitted.

This year, we received a record number of submissions—1,756 papers from 49 countries (ranging from the United States to Brunei Darussalam). In addition, we asked for the submission of posters as another vehicle of communicating innovative ideas at an early development stage; 123 poster submissions came in. Due to the record number of submissions, the Technical Paper and Poster Program Committees were forced to make difficult decisions in selecting papers and posters to maintain the quality and balance of the technical program. A double-blind paper/poster review system was introduced with the goal of improving the quality of the reviews. A very aggressive approach was followed in order for each paper to receive at least two meaningful and constructive reviews. The return rate for the paper reviews was 99.5% and 97.5% for the poster reviews. More than 3,700 reviews were

gathered. If the opinions of the reviewers differed, a third and, in some instances, a fourth review were sought. A total of 680 papers and 59 posters were selected, the lowest acceptance rate (38.7% for papers) in the history of ICRA. The 113 technical sessions were accompanied by three special video sessions and 14 tutorials/workshops on various robotics/automation topics of current research interest as well as 15 exhibitions from industries, research institutions, and national laboratories. The video proceedings include 40 video submissions on topics ranging from aerial vehicles to automation. Supplementing the technical presentations, the program was highlighted by plenary talks delivered by distinguished scholars: Prof. Paolo Dario on biorobotics science and engineering, Dr. Jun Tani on brain-inspired robotics, and Prof. Ron Fearing on millirobots. It is interesting to note that the plenary sessions were held in the afternoon and gathered more than 600 attendees each.

Despite the low acceptance rate, the attendance was close to a record. We had 873 advance registrations and a total of 1,144 registrants as the final count. The workshops/tutorials had a registration of more than 300 attendees. The close proximity of the meeting rooms made it easier for the attendees to switch from a session to another. One important note is that we accommodated, with the help of Roz Snyder, more than 20 RAS committee meetings. The Town Hall meeting on Tuesday, 16 May, and the Young Professionals Lunch on Thursday, 18 May, were also major successes.



Norman Caplan, Nikos Papanikolopoulos, and C.S. George Lee.

We would like to express our sincere appreciation and thanks to the entire Organizing Committee and the Technical Paper and Poster Program Committees, the reviewers and the local arrangements staff for their contributions and tireless efforts toward the success of ICRA 2006. In particular, we want to express our sincere thanks to Pei-Ling Lee for the digest creation. We also extend our sincere thanks to C.L. Philip Chen and his students who worked tirelessly to finish our conference DVD with video proceedings. The linking of the papers and digests in the DVD, as well as the fact that the DVD works on a Mac, were other innovations. Numerous students, in particular Mike Janssen and Andrew Drenner from the University of Minnesota, enabled us to execute such a complex process so smoothly. Finally, our special thanks goes to all the authors for contributing their research work, the participants, and the exhibitors in making the 2006 IEEE International Conference on Robotics and Automation a memorable event. The three of us sincerely hope that you enjoyed this conference. It was a great learning experience for us, especially if one considers the many bold steps that we had to undertake.

Nikos Papanikolopoulos, University of Minnesota
 C.S. George Lee, National Science Foundation
 Norman Caplan



Dessert is served at ICRA.



The Young Professionals Lunch is a success.

ICRA 2006 Proceedings

If you were unable to attend ICRA 2006, you may still purchase copies of the ICRA Conference Proceedings DVD. The DVD includes the regular papers, posters, and video proceedings. To order, send a request with a bank check or money order to the ICRA Conference Treasurer for US\$100 per copy.

A few copies of the workshop materials CD are also available for US\$45 each, plus shipping for outside the United States/Canada.

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ICRA 2006 Awards

The following awards are presented to participants in the IEEE International Conference on Robotics and Automation. In the event of multiple winners, the prize is shared.

ICRA Best Video Proceedings Award

- ◆ “Climbing Walls with Microspines” by Alan T. Asbeck, Sangbae Kim, Arthur J. McClung, Mark R. Cutkosky, Stanford University

Finalists in this category were:

- ◆ “The CITY Climber: A New Generation of Climbing Robots” by Matthew Elliott, William Morris, and Jizhong Xiao, City College of New York
- ◆ “Adaptive Network of Heterogeneous Ground and Aerial Vehicles for Situational Awareness” by Vijay Kumar, Anthony Cowley, Luiz Chaimowicz, Ben Grocholsky, Ani Hsieh, Jim Keller, and Camillo J. Taylor, University of Pennsylvania

Kayamori Best Automation Paper Award

- ◆ “A 2-DOF Electrostatic Sheet Conveyer Using Wire Mesh for Desktop Automation” by Akio Yamamoto, Hisatomo Yoshioka, and Toshiro Higuchi, University of Tokyo

Finalists in this category were:

- ◆ “Flow Diversion Approaches for Shipment Routing in Automatic Cargo Handling Systems” by Raymond Cheung, Daniel Mo, and Allen Lee, Hong Kong University of Science & Technology
- ◆ “Dynamics and Control of a Gravity-Assisted Underactuated Robot Arm for Assembly Operations Inside an Aircraft Wing-Box” by Binayak Roy and Harry Asada, Massachusetts Institute of Technology

**ICRA Best Manipulation Paper Award
(Sponsored by Ben Wegbreit)**

- ◆ “Dynamic Regrasping Using a High-Speed Multifingered Hand and a High-Speed Vision System” by Noriatsu Furukawa, Akio Namiki, Senoo Taku, and Masatoshi Ishikawa, University of Tokyo

Finalists in this category were:

- ◆ “Study on Hemispherical Soft-Fingered Handling for Fine Manipulation by Minimum D.O.F. Robotic Hand” by Takahiro Inoue and Shinichi Hirai, Ritsumeikan University
- ◆ “Bio-Mimetic Study on Pinching Motions of A Dual-Finger Model with Synergistic Actuation of Antagonist Muscles” by Kenji Tahara, BME Research Center RIKEN; Zhiwei Luo, BME Research Center RIKEN, Shanghai Jiaotong University; Ryuta Ozawa, Ritsumeikan University; Ji-Hun Bae, Ritsumeikan University; and Suguru Arimoto, Ritsumeikan University, BME Research Center RIKEN

**ICRA Best Vision Paper Award
(Sponsored by Ben Wegbreit)**

- ◆ “Depth Perception in an Anthropomorphic Robot That Replicates Human Eye Movements” by Fabrizio Santini and Michele Rucci, Boston University

Finalists in this category were:

- ◆ “CMOS+FPGA Vision System for Visual Feedback of Mechanical Systems” by Kazuhiro Shimizu and Shinichi Hirai, Ritsumeikan University
- ◆ “Attenuating Pixel-Locking in Stereo Vision via Affine Window Adaptation” by Andrew Stein, Robotics Institute, Carnegie Mellon University; Andrés Huertas, Jet Propulsion Laboratory; and Larry Matthies, Jet Propulsion Laboratory

ICRA Best Conference Paper Award

- ◆ “Outdoor SLAM Using Visual Appearance and Laser Ranging” by Paul Newman, David Cole, and Kin Ho, University of Oxford

Finalists in this category were:

- ◆ “A Rao-Blackwellized Particle Filter for Topological Mapping” by Ananth Ranganathan and Frank Dellaert, Georgia Institute of Technology
- ◆ “Development of a New Humanoid Robot WABI-AN-2” by Yu Ogura, Hideki Kondo, Akitoshi Morishima, Hun-ok Lim, and Atsuo Takanishi, Waseda University
- ◆ “Blades: A New Class of Geometric Primitives for Feeding 3D Parts on Vibratory Tracks” by Onno Goemans, Utrecht University; Ken Goldberg, University of

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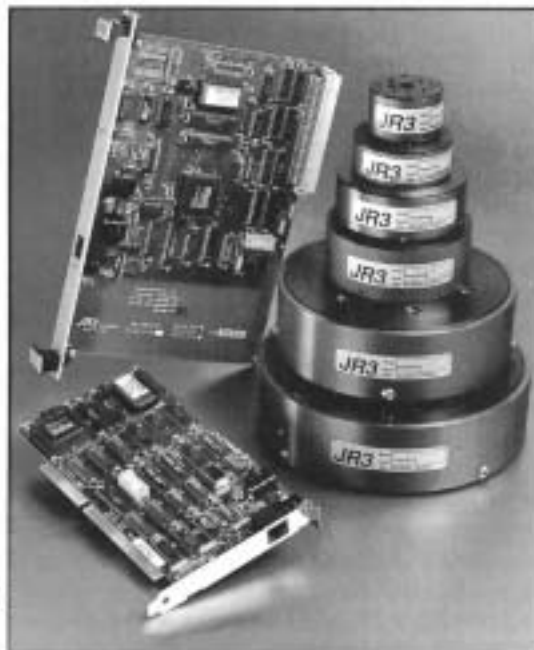
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Hirzinger to Receive 2007 TFA Award

The IEEE Board of Directors has named Prof. Dr.-Ing. Gerd Hirzinger, director of the Institute of Robotics and Mechatronics of the German Aerospace Center (DLR), as the recipient of the 2007 IEEE Robotics and Automation Award with the following citation: For contributions in robot mechatronics, telerobotics, man-machine interface research, and space robotics.

The award will be presented at the 2007 IEEE International Conference on Robotics and Automation, which will take place in Rome, Italy, in April 2007.

Prof. Hirzinger received his Dipl.-Ing. degree and the doctor's degree from the Technical University of Munich in 1969 and 1974, respectively. In 1969, he joined DLR (the German Aerospace research establishment) where he first worked on fast digital control systems. In 1976, he became head of the automation and robotics laboratory of DLR, where he and his coworkers received several awards for innovative technology transfer from robotics research to applications. In 1991, he received a joint professorship from the Technical University of Munich. Since 1992, Prof. Hirzinger has been director at DLR's Institute for Robotics and Mechatronics.

He was prime investigator of the space robot technology experiment ROTEX, the first remotely controlled robot in space, which flew on board the shuttle *Columbia* in April 1993. Since then, he and his coworkers have developed dynamic interaction schemes for free-flying space robots (based on their experiences with ETS VII, Japan's free-flying space robot). Prof. Hirzinger has developed the most advanced torque-controlled ultralightweight robots and multifingered hands. In 2005, he sent a small torque-controlled robot to the space station ISS, thus qualifying his lightweight robot technologies for space and simultaneously demonstrating telepresence concepts with visual and haptic feedback. His space-mouse/space-ball, a spin-off from his space technology work, became the world's most popular three-dimensional (3-D) man-machine interface. Robot manufacturer KUKA is now going to commercialize his lightweight robots. He also has contributed to the evolution of medical systems, e.g., the first fully automatic (i.e., robotic) guidance of endoscopes in minimally invasive surgery, the development of a new surgical robot, and the development of an innovative artificial heart.

California at Berkeley; and A. Frank van der Stappen, Utrecht University

ICRA Best Student Paper Award

- ◆ "Motion Planning for Robotic Manipulation of Deformable Linear Objects" by Mitul Saha, Stanford University, and Pekka Ito, University of Vasa, Finland
Finalists in this category were:
- ◆ "Scalable Shape Sculpting via Hole Motion: Motion Planning in Lattice-Constrained Modular Robots" by Michael De Rosa, Carnegie Mellon University; Seth Goldstein, Carnegie Mellon University; Peter Lee, Carnegie Mellon University; Jason Campbell, Intel Research Pittsburgh; and Padmanabhan Pillai, Intel Research Pittsburgh
- ◆ "Programmable Central Pattern Generators: An Application to Biped Locomotion Control" by Ludovic Righetti and Auke Ijspeert, EPFL, Switzerland

Best ICRA 2006 Reviewers

Dedicated and conscientious reviewers are essential to the success of the conference; a special award has been established to recognize their hard work in what is often a thankless task.

Winners of this award were Raja Chatila, LAAS-CNRS, and Shigeki Sugano, Waseda University, with honorable mention given to Stergios Roumeliotis, University of Minnesota, and Jean-Pierre Merlet, INRIA.

IEEE Institute Awards and Robotics and Automation Society Awards

At the ICRA awards banquet, the Society recognized the achievement and service of outstanding members.

IEEE Vice President Cecilia Desmond presented the IEEE Field Award in Robotics and Automation to George Bekey of the University of Southern California. Then, RAS President Richard Volz formally recognized all of the Society's new IEEE Fellows and presented the following Robotics and Automation Society awards.

RAS Pioneer in Robotics and Automation Award

- ◆ Suguru Arimoto, Department of Robotics, Faculty of Science and Engineering, Ritsumeikan University, for his work on PD and PID control, iterative learning control, and passivity-based control of nonlinear mechanical systems, which represents a source of reference for virtually any scientists dealing with complex robotic systems.

RAS Distinguished Service Award

- ◆ Georges Giralt, LAAS-CNRS, for his contributions and leadership in organizing and assisting RAS conferences and in establishing liaisons with other robotics organizations.
- ◆ Arthur C. Sanderson, Rensselaer Polytechnic Institute, for his contributions as president in leading the Society from its infancy, and for service on innumerable committees and as an international ambassador for the Society.

RAS Local Chapter Grants		
Chapter	Activity	Grant
Portugal-RAS Chapter	The Portuguese Robotics Open 2006	US\$1,000
University of Twente	Region 8 Student	US\$1,000
The Netherlands-IEEE Student Branch	Firefighter Robotics Competition	
Mexico Chapter	The 2nd Mexican Students Robotics Competition	US\$1,000
Student Chapter, University del Sol, Mexico	Congress on Electronics Robotics and Automotive Mechanics	US\$1,000
Italy Chapter	A Short Summer Course in Computer Vision and Robotics for Ph.D.- and Master's-Level Students	US\$1,000
Bulgaria Chapter	National Conference Robotics and Mechatronics and Annual Meeting of Bulgarian Robotics Society	US\$600

- ◆ T.J. Tarn, Washington University, St. Louis, for his leadership in conferences and for his promotion of the Society within the IEEE.

Early Industry/Government Career Award in Robotics and Automation

This award is bestowed on individuals in the early stage of their careers in government or industry who have made an identifiable contribution or contributions that have had a major impact on the robotics and/or automation fields.

- ◆ Jingshan Li, General Motors Research & Development Center, for his significant contribution to the technical field of automation science and engineering, in such areas as modeling and analysis of manufacturing systems, performance evaluation and bottleneck identification, and production line design using AGVs.

Early Academic Career Award in Robotics and Automation

This award is bestowed on individuals in the early stage of their careers at a college or university who have made an identifiable contribution or contributions that have had a major impact on the robotics and/or automation fields.

- ◆ Warren Dixon, University of Florida, for his remarkable achievements at his career stage, including impressive publication record, building a solid robotics program and attracting substantial funding, being selected to receive the National Science Foundation Career Award, receiving the ORNL Early Career Award, and for his innovative research in the areas of

nonlinear control design for robotic systems and of visual servo control.

RAS Chapter of the Year Award

- ◆ Italy, Paolo Fiorini, chair

RAS Most Active Technical Committee

- ◆ Intelligent Transportation, cochairs: Alberto Broggi, Christian Laugier, and Urbano Nunes

Best Paper Awards

Each year the editorial boards of the two IEEE transactions award Best Paper Awards. This year's winners are:

2005 King-Sun Fu Memorial Best

IEEE Transactions on Robotics Paper Award:

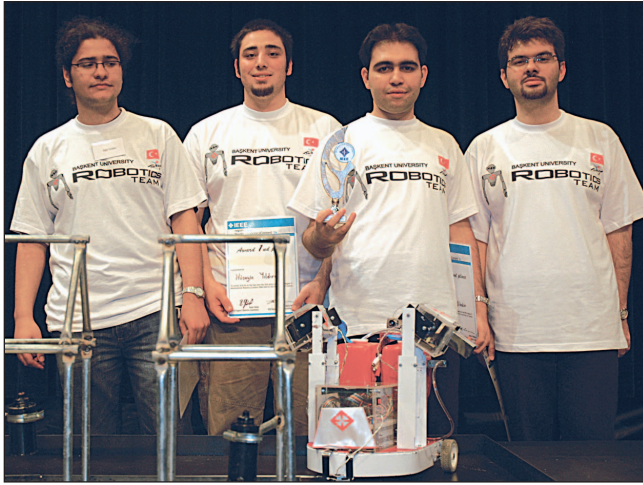
- ◆ "Active Filtering of Physiological Motion in Robotized Surgery Using Predictive Control," R. Ginhoux, J. Gangloff, M. de Mathelin, L. Soler, M.M. Arenas Sanchez, and J. Marescaux, University of Strasbourg, vol. 21, no. 1, pp. 67-79, February 2005.

IntelliBrain™-Bot Educational Robot

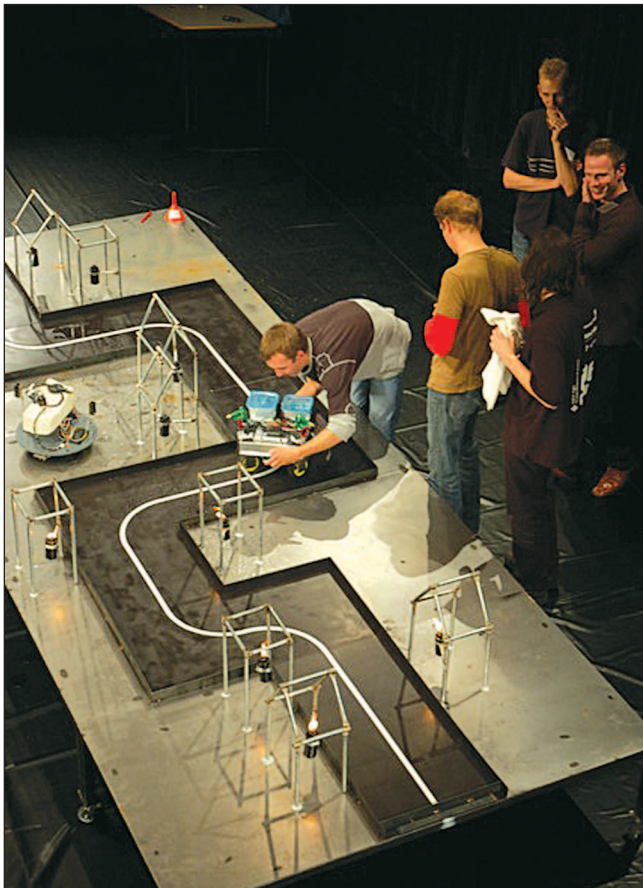


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Best *IEEE Transactions on Automation Science and Engineering* Paper Award

- ◆ “Overlapping Decomposition: A System-Theoretic method for Modeling and Analysis of Complex Manufacturing Systems,” Dr. Jingshan Li, General Motors R&D Center, Manufacturing System Research Lab, vol. 2, no. 1, pp. 40-53, January 2005.

Robotics and Automation Society Special Recognition

The following individuals were also recognized for their service to the IEEE Robotics and Automation Society (RAS) as Society officers or AdCom members.

- ◆ Kazuo Tanie, Tokyo Metropolitan University, President 2004–2005
- ◆ Makoto Kaneko, Hiroshima University, Vice President for Member Activities, 2004–2005
- ◆ Roland Siegwart, EPFL-Lausanne, Vice President for Technical Activities, 2004–2005
- ◆ Antonio Maciejewski, Colorado State University, Vice President for Finance, 2004–2006

Class of 2005 AdCom Members

- ◆ Li-Chen Fu, National Taiwan University
- ◆ Krzysztof Kozlowski, Poznan Institute of Technology
- ◆ Antti J. Koivo, Purdue University
- ◆ Sang-rok Oh, Ministry of Information and Communications, Republic of Korea
- ◆ Alison Okamura, Johns Hopkins University
- ◆ Nikolaos Papanikolopoulos, University of Minnesota

RAS Local Chapter Grants

Membership Vice President Antonio Bicchi announced that at its May 2006 meeting in Orlando the Membership Activities Board approved six grants for RAS local chapter activities (see “RAS Local Chapter Grants” table on page 13).

The Society provides support for local activities including student competitions, short courses, and small conferences that are partially or wholly supported by RAS chapters.

Grants are awarded twice a year by the AdCom upon the recommendation of the Member Activities Board (MAB) based on the applications submitted by RAS local and student chapters. To apply for a grant, please complete the RAS Local Chapter Grant Application. To be considered at the next meeting of the MAB, new grant applications should be submitted by 15 September to the corresponding chair of the Local Chapters Standing Committee, Alfredo Weitzenfeld, with a copy to the Society Activities Coordinator.

Region 8’s First Student Robotics Contest

During the weekend of 25–30 May, the IEEE Student Branch Twente organized the SRC2006 on the campus of the University of Twente in the Netherlands. This is a new international event, supported in part by the RAS Member Activities Board, in which every student branch from IEEE Region 8 was invited to participate. There were teams participating from Egypt, Italy, Turkey, Serbia and Montenegro, and The Netherlands. Teams from the Ukraine, Nigeria, and Jordan also wanted to participate but had to withdraw at the last minute due to visa issues.

The assignment was published 17 April. Teams had six weeks to build a robot that could autonomously find and extinguish fires along a track.

The contest was a success! Everyone who participated in the event, including the organizing committee, had a great time. In the end, the team from Turkey proved to be the strongest, followed closely by the team from the Netherlands. The team from Italy won the prize for the best robot design, despite the fact that they had problems with their electronics.

Other photos of the event can be found at <http://www.ieee.utwente.nl/gallery/albums.php>.

Stefan Henzen
University of Twente IEEE Student Branch

Women in Robotics for Communication and Outreach

On 7 and 8 March 2006, a set of organized sessions “Women in Robotics, Human Science and Technology” and a panel discussion “Women in Robotics, Human Science and Society” were held successfully at the 9th International Conference on Intelligent Autonomous Systems (IAS-9) in Kashiwa Campus of the University of Tokyo, Japan.

Mihoko Otake, an assistant professor of Science Integration Program-Humans of the University of Tokyo, and Keiko Homma, a senior research scientist at the National Institute of Advanced Industrial Science and Technology (AIST), organized the events in order to discuss effective styles of research and education for society as

well as to encourage the next generation of students worldwide, especially women, to enter and develop their careers in robotics, human science, and technology.

Nine women in robotics presented their studies to 150 participants of the conference at the organized session. The panel discussion was open to the public and sponsored by the IEEE RAS Japan Chapter, with support from the IEEE Japan Council WIE Affinity Group and Japan Inter-Society Liaison Association Committee for Promoting Equal Participation of Men and Women in Science and Engineering (EPMEWSE). Panelists from the United States, Europe, and Japan described their practices, which raised active discussions. Participants were conference attendees, female students, professors, and journalists.

The first panelist, Prof. Otake, emphasized that the purpose of “Women in Robotics” activities is to facilitate communication and outreach across research fields, generations, and countries in terms of women. The second talk was given

by Prof. Maria Gini of the University of Minnesota who introduced activities aimed at promoting participation in the field of engineering for minorities such as women and Native Americans at the university. The third speaker, Prof. Rolf Pfeifer of the University of Zurich, described the “Roberta” project, which is a robot education program for 12- to 15-year-old students, coordinated by the AIS laboratory at the Fraunhofer Institute in Germany. The final talk was given by Prof. Hisako Otsubo of the University of Tokyo, who is a secretary of the EPMEWSE. She reported the present status of gender equality in science and engineering in Japan.

To facilitate online communication and outreach, the Web site “Women in Robotics Towards Human Science, Technology and Society” (<http://women.ws100h.net/>) has been established. About 60 women in robotics were registered on a link list in June 2006, and the number has been growing. The link list is valuable, especially for young women looking for role models, mentors, and friends. In July, a special issue on

“Women in Robotics” was published in the *Journal of Robotics Society of Japan (JRSJ)* (vol. 24, no. 5). The issue contains 12 articles. Contributors were 16 women in robotics in Japan, the United States, Spain, Switzerland, and China. The abstracts of the organized session and the panel discussion at IAS-9 and the special issue of *JRSJ* are available on the Web site.

Through these activities, the international community “Women in Robotics” has emerged. We are especially looking for women in robotics and related research fields, but we welcome the participation of all who are interested in these emergent activities. For more information, please visit <http://women.ws100h.net/>.

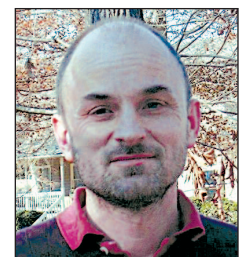
Mihoko Otake and Keiko Homma



“Women in Robotics” panel discussion at IAS-9.

Ian Walker Elected RAS VP Finance

Ian Walker of Clemson University has been elected RAS vice president of Financial Activities. He has previously served on the editorial board of *IEEE Robotics & Automation Magazine* and as an associate vice president for publications.



Ian Walker.