Forward

The 2000 IEEE International Conference on Robotics and Automation, ICRA2000, held in San Francisco April 24-26, 2000, is the 17th in a series of annual conferences sponsored by the IEEE Robotics & Automation Society.

During the 20th century, the body of concepts, methods, and systems that we refer to as "Robotics and Automation" emerged as an major field. While its origins can be traced to the industrial revolution that began more than 150 years ago, it continues to evolve today. Now, 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. These advances in intelligent machines will impact a wide range of areas in manufacturing, space, underwater, services, health care, entertainment, design, and automation, among others. The emphasis on these new frontiers is reflected in the theme for the 2000 Conference, Robotics and Automation: The Next Generation. The 2000 conference provides a unique opportunity for researchers and engineers in our community to reflect on the field's accomplishments, new developments, and future directions.

Our goal for ICRA 2000 was to develop a technical program with the highest quality in content and organization. In planning the conference, a special effort was made to create a conference structure that is conducive to quality interactions between participants. The structure, which is reflected in conference Proceedings, provides for a reduced number of parallel tracks and includes, in addition to the regular tracks, a series of theme-oriented symposia. Organized by leading researchers in their respective fields, these symposia serve to present summaries of many of the sub-disciplines that comprise the field of robotics and automation. The 28 symposia sessions cover topics ranging from the field's foundations to the emerging applications of robotics and manufacturing automation.

To provide the participants with a more detailed outline of the technical program, we have edited this Conference Digest which represents a visual brief of the technical sessions. Each session in the program is displayed as a full page in this Digest.

The entire ICRA2000 Program consists of 111 technical sessions for a total of 641 papers chosen from the nearly 1100 submissions. The 641 selected papers, as a whole, stress the conference theme, which is further highlighted by four keynote presentations and two plenary sessions. The four keynote presentations are: Vision - Enabling Robots to Sense,

Control and Interact, by Takeo Kanade, Controlling Intelligent Machines, by Hendrik Van Brussel, Motion Planning: A Journey of Robots, Molecules, Digital Actors, and Other Artifacts, by Jean-Claude Latombe, and Hands On: Haptics and Telesurgery, by Kenneth Salisbury. Organized by Georges Giralt, the two plenary sessions are entitled Robotics: the 20th Century and Beyond and National and International R&D Projects and Programs. The Banquet address, Brains and Brawn in Humanoid Autonomy, is given by Stephen Jacobsen. The program also includes a panel on Education, two video sessions, five tutorials, and nine workshops.

We would like to express our appreciation and thanks to all the members of the Organizing Committee, Technical Program Committee, Video Proceedings Committee for their efforts and contributions to the program and organization of this conference. Our special thanks go to the volunteers and staffs for the long hours and hard work they have generously given to the conference. But above all ICRA2000 is the result of the contributions of its authors. We would like to thank all the authors, speakers, participants, and organizers for taking part in and contributing to ICRA2000.

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Brian Carlisle   *Oussama Khatib*
General Chairman   *Program Chairman*

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Ang, Marcelo H. Jr.	Fukuda, Toshio	Lee, Tong Heng	Takanishi, Atsuo
Arai, Fumihito	Hashimoto, Hideki	Li, Zexiang	Tanie, Kazuo
Asada, Minoru	Hirose, Shigeo	Luo, Ren C.	Trevelyan, James
Asama, Hajime	Ikeuchi, Katsushi	McCarragher, Brendan	Viswanadham, N.
Billingsley, John	Inoue, Hirochika	Miura, Hirofumi	Xu, Yangsheng
Chung, Myung Jin	Jarvis, Ray	Nakamura, Yoshi	Yokokohji, Yasuyoshi
Chung, Wankyun	Kaneko, Makoto	Oh, Sang-Rok	Yoshikawa, Tsuneo
Corke, Peter	Kosuge, Kazuhiro	Rosenblatt, Julio	Yuta, Shin'ichi
Durrant-Whyte, Hugh	Kuniyoshi, Yasuo	Sugano, Shigeki	
Fu, Li-chen	Lee, Beom-Hee	Suh, Il Hong	

Europe/Mediterranean

Alami, Rachid	Dauchez, Pierre	Hiller, Manfred	Melchiorri, Claudio
Ayache, Nicholas	DeLuca, Alessandro	Hirzinger, Gerd	Merlet, Jean-Pierre
Bicchi, Antonio	del Pobil, Angel	Horaud, Radu	Rimon, Elon
Bidaud, Philippe	Deschutter, Joris	Husty, Manfred	Rudas, Imre
Bruyninckx, Herman	Dillmann, Ruedigger	Kaynak, Okyay	Siciliano, Bruno
Casals, Alicia	Egeland, Olav	Khalil, Wisama	Sun, Li Ning
Castellanos, Jose A.	Elfes, Alberto	Kozlowski, Krzysztof R.	Swevers, Jan
Chatila, Raja	Erkmen, Aydan	Kyriakopoulos, Kostas	Tzafestas, Spyros G.
Chaumette, Francois	Espiau, Bernard	Lane, Dave	Villani, Luigi
Coste-Maniere, Eve	Featherstone, Roy	Laugier, Christian	Zisserman, Andrew
Crowley, Jim	Giralt, Georges	Laumond, Jean-Paul	
Dario, Paolo	Giua, Alessandro	Lenarcic, Jadran	

America

Agrawal, Sunil	Fearing, Ron	Kress, Reid	Salcudean, Tim
Akeel, Hadi	Fiorini, Paolo	Kumar, Vijay	Sanderson, Arthur
Akella, Prasad	Ghosh, Bijoy K.	LaValle, Steven	Sarkar, Nilanjan
Armstrong, Brian	Goldberg, Ken	Lee, C. S. George	Schaal, Stefan
Asada, Harry	Goldenberg, Andrew	Lee, Kok-Meng	Schempf, Hagen
Atkeson, Chris	Gupta, Kamal	Lee, Sooyong	Shiller, Zvi
Baker, Harlyn	Hager, Gregory	Leonard, John	Simmons, Reid
Balch, Tucker	Hamel, William	Luh, John	Sobh, Tarek
Bejczy, Antal	Hannaford, Blake	Luh, Peter	Stentz, Anthony
Bekey, George	Hayward, Vincent	Lumelsky, Vladimir	Sukhatme, Gaurav
Benhabib, Beno	Hebert, Martial	Lynch, Kevin	Tahboub, Karim
Bobrow, Jim	Hodgins, Jessica	Maciejewski, Anthony	Tai, Yu-Chong
Bolles, Bob	Holland, Steve	Mason, Matt	Tarn, Tzyh-Jong
Book, Wayne	Hollerbach, John	Matthies, Larry	Taylor, Russell
Brooks, Rod	Hollis, Ralph	Mavroidis, Dinos	Thorpe, Chuck
Burdick, Joel	Horowitz, Roberto	McCarthy, Michael	Trinkle, Jeff
Buss, Martin	Hsia T.C. Steve	Murphy, Robin	Valavanis, Kimon
Canny, John	Hutchinson, Seth	Musliner, David	Van der Loos, Machiel
Chirikjian, Greg	Jain, Abhinandan	Nayar, Shree	Waldron, Ken
Choset, Howie	Kanayama, Yutaka	Nelson, Bradley	Whitney, Dan
Clark, James	Kavraki, Lydia	Ning, Xi	Will, Peter
Craig, John J.	Kawamura, Kazuhiko	Orin, David	Xiao, Jing
Crisman, Jill	Kazerooni, Hami	Pai, Dinesh	Youcef-Toumi, Kamal
Cutkosky, Mark	Kesavadas, T.	Papanikolopoulos	Yuan, Xiaobu
Desrochers, Alan	Khosla, Pradeep	Pollard, Nancy	Yuh, Junku
Dubowsky , Steve	Klafter, Richard	Ponce, Jean	Yun, Xiaoping
Dudek, Gregory	Koditschek, Dan	Roth, Bernard	Zheng, Yuan F.
Falconer, David	Koivo, Antti	Rus, Daniela	

Monday April 24

ICRA2000 Opening

Plenary Session: Chair Ruzena Bajcsy; **Vision - Enabling Robots to Sense, Control and Interact – Takeo Kanade**

Time									
13:00–13:20	ICRA2000 Opening								
13:20–14:20	Plenary Session: Chair Ruzena Bajcsy; Vision - Enabling Robots to Sense, Control and Interact – Takeo Kanade								
14:40–16:20	Path Planning	Mapping Localization 1	Grasping Manipulation	Kinematics	Mechanisms	Architectures	Micro Robots	Manufacturing Design	Space Robots and Rovers
16:40–18:20	Autonomous Robots	Space and Underwater	Control 1	Range Sensing	Part Feeding Fixturing	Prototyping Automation	Actuators 1	Video Session 1	Rehabilitation
18:40–21:00	Welcome Reception and a Special Plenary Session: Robotics the 20th Century and Beyond: G. Giralt (Chair), T. Kanade, J.-C. Latombe, N.J. Nilsson, B. Roth								

Tuesday April 25

Time									
08:20–10:00	Assembly Planning	Landmarks Modeling	Flexible Robots	Robot Control	Dexterous Manipulation	Robot Learning	Transmission Methods	Robots in Manufacturing	Surgical Robots
10:20–12:00	Sensing Control 1	Target Tracking	Redundant Manipulators	Mobile Robotics	Grasping Contact	Flexible Automation	Reconfigurable Robots	Video Session 2	Underwater Robotics
12:00–13:00	Lunch								
13:00–14:00	Keynote: Controlling Intelligent Machine – Hendrik Van Brussel								
14:20–16:00	Nonholonomic Planning	Applications of Sensing	Neural Networks	Cooperative Robots	Mechatronics	Parallel Manipulators	Applications of Grasping	Teleoperation 1	
16:30–21:30	San Francisco Bay Dinner Cruise								

Wednesday April 26

Time									
08:20–10:00	Mobile Robots 1	Visual Servoing 1	Fuzzy Logic	Motion Planning	Human Augmentation	Medical Robotics	Static/Dynamic Contact	Discrete Event 1	Humanoids
10:20–12:00	Sensing Motion Planning	Navigation Mapping	Control Applications 1	National and International R & D Programs G. Giralt - R. Bajczy, G. Bekey, S. Bensasson, H. Inoue, D. Okhotsimsky, S. Sastry, M. Uhran, S. Lide			Parallel Mechanisms	Manufacturing Scheduling	Haptic Interface 1
12:00–13:30	IEEE Robotics & Automation Society Luncheon and Awards								
13:40–14:40	Keynote: Motion Planning: A Journey of Robots, Molecules, Digital Actors, and Other Artifacts – Jean-Claude Latombe								
15:00–16:40	Vehicle Mechanics	Mapping Localization 2	Redundancy	Real-Time Tracking	Humanoid Motion	Industrial Robots	Legged Locomotion 1	Production Control	Teleoperation 2
17:00–18:40	Robotic Cooperation 1	Visual Servoing 2	Trajectory Control	Constrained Planning	Haptics	Entertainment	Locomotion Techniques	Supervisory Control-DEDS	Robotics in Medicine
20:00–22:00	Conference Banquet: Brains and Brawn in Humanoid Autonomy – Stephen Jacobsen								

Thursday April 27

Time									
08:20–10:00	Mobile Robots 2	Localization	Control 2	Robot Dynamics	Visual Reconstruction	Frontier Environments	Legged Locomotion 2	Rapid Prototyping	Teleoperation 3
10:20–12:00	Robotic Cooperation 2	Vision-Based Control	Learning 1	Control Architectures	MEMS	Stiffness Compliance	Biped Robots	Discrete Event 2	Haptic Interface 2
12:00–13:00	Lunch								
13:00–14:00	Keynote: Hands On- Haptics and Telesurgery – J. Kenneth Salisbury								
14:20–16:00	Manipulator Planning	Mapping Localization 3	Modeling and Control	Grasp Analysis	Education Panel Aydan Erkmen	Identification	Actuators 2	Flexible Assembly	Collision Distance
16:20–18:00	Sensing Control 2	Sensing for Navigation	Learning 2	Grasping Force Control	Novel Sensing Devices	Dynamics Optimization	Bipedal Climbing	Control Applications 2	Human/Robot Cooperation
18:30–19:30	Farewell								

Plenary Keynotes and Special Sessions

Monday, April 24

Plenary Session: 13:20-14:20, Ballroom 5
Chair: Ruzena Bajcsy
Vision - Enabling Robots to Sense, Control and Interact
Takeo Kanade, Carnegie Mellon University

Special Session: 19:20-21:00, Ballroom 5
Chair/Moderator: Georges Giralt, LAAS-CNRS
Robotics: The 20th Century and Beyond
T. Kanade, Carnegie Mellon University; J.C. Latombe, N. Nilsson, B. Roth, Stanford University

Tuesday April 25

Plenary Session: 13:00-14:00, Ballroom 5
Chair: Patrick Eicker, Sandia National Laboratories
Controlling Intelligent Machine
Hendrik Van Brussel, Katholieke Universiteit Leuven

Wednesday April 26

Plenary Session: 13:40-14:40, Ballroom 5
Chair: Hirochika Inoue, Tokyo University
Motion Planning: A Journey of Robots, Molecules, Digital Actors, and Other Artifacts
Jean-Claude Latombe, Stanford Univesity

Banquet: 20:00-22:00, Ballroom 5
Chair: Bernard Roth, Stanford University
Brains and Brawn in Humanoid Autonomy
Stephen Jacobsen, University of Utah

Thursday April 27

Plenary Session: 13:00-14:00, Ballroom 5
Chair: Paolo Dario, ARTS-SSSUP, Pisa
Hands On: Haptics and Telesurgery
Kenneth Salisbury, Stanford University