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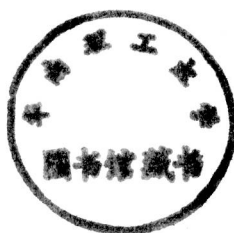
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The Institute of Electrical and Electronics Engineers, Inc.¹

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April 22 - 28, 1996
Minneapolis, Minnesota

Sponsored by
IEEE Robotics and Automation Society

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Foreword

The 1996 IEEE International Conference on Robotics and Automation is the 13th meeting sponsored by the Robotics and Automation Society. This year Minneapolis, Minnesota — a city surrounded by organizations that utilize robotics and automation in areas such as biomedical engineering, manufacturing, space, and food processing is the host location. As in the past, the Conference provides an excellent forum and opportunity for technologists, engineers, and scientists to meet and assess the latest developments in this fast growing field. As we start the five-year countdown to the next century, it is appropriate to gather the leaders in the automation and robotics area and begin to prepare for an exciting future. The twenty-first century will become the century of intelligent machines in support of mankind. Therefore the conference theme "*Technical Innovations in Robotics and Automation for Increased Utility and Prosperity*" is representative of the discussions and deliberations that will launch progress into the future.

A record number of 910 papers from 39 countries, covering a wide spectrum of technical areas, were submitted to the Technical Program Committee (TPC) for consideration. A conscientious effort was made by the TPC to balance the program among papers in theoretical development, experimentation, and applications, and we regret that many excellent papers could not be accommodated. During an all-day TPC meeting in December, 1995 and based on the reviewers' comments on each paper, the TPC selected 588 papers, covering recent advances in all aspects of robotics and automation for presentation. The TPC focus was on technical excellence, balance, and broad coverage of various application areas to insure response to the conference theme.

Supplementing the technical presentations, the Program includes opening plenary and dinner addresses as well as a unique plenary session discussing industry's viewpoint as represented by the Robotics Industries Association (RIA), and an evening panel discussion focusing on the *Grand Challenges for Robotics and Automation*. In addition, the Program also offers several tutorials and workshops on the day before and on the day after the technical-session presentations.

We are grateful for the assistance of Dee Dee Dexter of the School of Electrical and Computer Engineering at Purdue University in handling the manuscripts and generating thousands of letters to the authors, and Denis Gracanin of the University of Southwestern Louisiana in putting the conference program and information on the World Wide Web. We like to extend our sincere thanks to the Vice Chairpersons and the members of the TPC for their effort in processing the reviews of the papers and the selection of papers in such a short time period, and also the external reviewers for their prompt response and valuable comments on the papers they reviewed. We also thank the Organizing Committee members, Peter B. Luh, Rajiv V. Dubey, T. J. Tarn, Nikolaos Papanikolopoulos, Maria Gini, Kimon P. Valavanis, and Harry Hayman for their tireless efforts in making this Conference a success.

Finally, a special thanks is owed to all the authors for contributing their research works, the participants, the exhibitors, and financial contributors for making the 1996 IEEE International Conference on Robotics and Automation a memorable event.

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**1996 IEEE International Conference on Robotics and Automation
Technical Session Schedule**

Room	Salon B	Salon C	Salon E	Salon F	Salon G	Duluth	Marquette	LaSalle	Hennepin	Carver	Dir. Row 2	Dir. Row 3	Dir. Row 4
April 24/7 Session 8:00 - 8:45													
	1	2	3	4	5	6	7	8	9	10	11	12	13
Plenary Session: "Enhancing Human Capacity Through Intelligent Systems" by Dr. Joseph Breda, Asst. Director for Engineering, NSF (in Salon D)													
WA I 9:00 - 10:40	Tactile Sensor Technologies	Techniques for Robot Programming	Space Robots I	Vision-Guided Navigation	Motion and Path Planning I	Redundant Robots I	Workpiece Localization & Rearrangement of Objects	Petri Nets	Actuators	Biped Locomotion	Adaptive Robot Control	Force Control	Dynamics Identification
WA II 11:00 - 12:40	Sonar Sensing Techniques	Friction Compensation Control	Space Robots II	Outdoors Navigation	Motion and Path Planning II	Redundant Robots II	Fixture Design I	Flexible Manufacturing Systems	Hydraulic Interface	Adaptive and Dynamic Bipedal Locomotion (I)	Discrete Event & Industrial Control	Force Control & Manipulation	Calibration I
WP I 14:00 - 15:40	Multi-sensor Fusion	Control Architectures	Space Robots III	Environment Modeling	Collision Detection	Flexible Robots I	Fixture Design II	Manufacturing System Design and Layout	Surgical Robots	Mobile Robot Navigation I	Robot Control I	Mine and Field Applications	Calibration II
WP II 16:00 - 17:40	Human-Robot Coordination	Mechanisms I	Application-Driven Teleoperation (I)	World Model Generation	Collision Avoidance	Flexible Robots II	Design of Parts and Material Handling	Discrete Event Dynamic Systems	Bio-Robotic Systems	Mobile Robot Navigation II	Robot Control II	Hazardous Industrial Applications	Mechanisms II
Special Panel Discussion: The "Grand Challenges" for Robotics and Automation. Organized by George Bekey and Jill Crisman. (in Room Marquette)													

Room	Salon B	Salon C	Salon E	Salon F	Salon G	Duluth	Marquette	LaSalle	Hennepin	Carver	Dir. Row 2	Dir. Row 3	Dir. Row 4
April 25/7 Session 8:00 - 8:45													
	1	2	3	4	5	6	7	8	9	10	11	12	13
Plenary Panel Discussion: "Research Frontiers: Industry's Viewpoint on Barriers to Rapid Implementation of Automation." Speakers: Philip Mumm, Guy Poth, Steven Hollman, Klaus Niekum. (in Salon D)													
TA I 9:00 - 10:40	Robotic Vision I	Contact I	Teleoperation I	Mobile Robot Localization	Cooperative Mobile Robots I	Redundant Robots III	Grasping Mechanisms	Geometric Modeling	Assembly I	Optimal Trajectory Planning	Optimal Robot Control	Neural Network Applications	Multirobot Systems
TA II 11:00 - 12:40	Robotic Vision II	Contact II	Teleoperation II	Mobile Robot Navigation III	Cooperative Mobile Robots II	Redundant Robots IV	Grasp Force Analysis	Model Generation & CAD	Assembly II	Singularly Consistent Motion Planning	Impact Control	Neural Net Control	Flexible Robot Modeling & Simulation
TP I 14:00 - 15:40	Active Vision	Contact State Transition in Assembly	Teleoperation III	Mobile Robot Navigation IV	Multiple Mobile Robots	Flexible Robots III	Grasp Synthesis	Underwater Robotics: Sensing, Navigation, and Control (I)	Precision Assembly	Micro Manipulation and Actuation	Hybrid Control I	Fuzzy Control Applications	Learning and Control
TP II 16:00 - 17:40	Real-Time Vision	Flexible Object Manipulation	Virtual Reality and Collaboration	Mobile Manipulation and Planning	Cooperating Robot Manipulators	Flexible Robots IV	Sensor-Based Grasping	Space and Underwater Robots	Task Planning & Scheduling	Micro/Macro Robotics	Hybrid Control II	Fuzzy/Genetic Control for Robots	Compliant Motion
Conference Banquet in The Grand Ballroom. Banquet Address by Dr. Bonnie J. Duharbar, NASA Johnson Space Center.													

Room	Salon B	Salon C	Salon E	Salon F	Duluth	Marquette	LaSalle	Hennepin	Carver	Dir. Row 1	Dir. Row 4
April 26/7 Session											
	1	2	3	4	5	6	7	8	9	10	11
FA I 8:00 - 9:40	Vision-Based Control	Nonholonomic Systems	Human Skill Acquisition	Control of Walking Robots	Trajectory Planning I	Grasping Strategy	Manufacturing Scheduling	Mobile Robot Control I	Multiple Robot Motion Planning	Robot Control III	Manipulator Design
FA II 10:00 - 11:40	Visual Tracking	Trajectory Planning for Nonholonomic Systems	Human-Robot Skill	Control of Walking Robots II	Path Planning with Uncertainty	Grasping	Estimation and Performance Measures	Mobile Robot Control II	Autonomous Vehicles	Robot Control IV	Kinematics
TP I 13:00 - 14:40	Vision-Based Manipulation	Tactile Sensing	Inspection	Motion Planning of Walking Robots	Motion and Path Planning III	Grasping and Manipulation	Manufacturing and Assembly	Motion Planning for Mobile Robots	Controls and Vision	Robot Control V	Mechanisms III
TP II 15:00 - 16:40	Object Recognition	Tactile Sensing Shape Estimation	Redundant Robots V	Walking/Mobile Robots	Motion and Path Planning IV	Neural Control and Feature Recognition	Navigation and Control	Mobile Robot Applications	Robot Control VI	Robot Control VII	Parallel Manipulators

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