

ROBOTICS AND AUTOMATION

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From the Editor's Desk



*Michael B. Leahy
Air Force Material Command
Robotics and Automation Center of Excellence (RACE)*

Welcome to another issue of *your* Newsletter. Two more issues and we hope to be sending issues of your Magazine. The emphasis on *your* is deliberate. The objective of the Magazine initiative is to provide value added services to you, our customer. We can best accomplish that with your comments and insight. Toward that end, a copy of the draft Magazine proposal is included in this issue. Please take the time to read it and provide constructive criticism. We are in the formative stage on many of the important implementation details, so there is still time to have a positive impact.

On the IEEE approval front, we are one step away from official permission to start Magazine publication in January 1994. The approval journey has had a few turbulent moments but should now be smooth sailing through final approval from the IEEE Technical Activities Board in June. After winter meetings in Chicago and New Jersey, Puerto Rico in June will be a nice change of venue.

We are proceeding under the assumption that approval is forthcoming. Therefore we will start soliciting technical articles at our annual conference in Atlanta. The initial target will be conference papers that match the Magazine objectives. However, conference publication is not a prerequisite for Magazine publication. We encourage your submissions, but with a twist. Stealing an idea, i.e. technology transfer, from the procurement community we are going to ask to review your ideas before reviewing a completed paper. Rather than sending in a full paper, we request that you initially provide an outline or extended abstract, preferably by email. An electronic version allows me to quickly pass the information along to the associate editors for feedback. Within two weeks we will provide comments and suggestions on preparing the manuscript or a recommendation that the topic, as submitted, is not suited for Magazine publication as a peer-reviewed technical article. This is also our first filter in distinguishing between information and peer review Magazine articles. In this manner we hope to avoid misguided efforts and to improve the quality of the draft submission, thereby reducing time to publication. Remember the objective of the Magazine is to build upon the existing newsletter base by adding high quality technical articles in the areas of prototypes, demonstration and evaluation, commercialization, and tutorials. The target audience is the practicing engineer.

Along with the increased emphasis on technical articles we will strive to improve our world view of robotics research. As a step in that direction, we wish to welcome Dr. Kazuhiro Kasuge from Nagoya University as an associate editor. Dr. Kasuge's primary responsibility is to solicit informational articles on research activities in the Pacific rim area. In the coming months we will be searching for volunteers to accept similar responsibilities for other international regions.

A close look at the masthead also reveals that Dr. John Baillieul has stepped down as an associate editor. John deserves a hearty round of thanks for his work on the newsletter and we wish him the best in his role as editor in chief of the IEEE Transactions on Automatic Control. John is also one of the seven society members promoted to the rank of Fellow in the IEEE. Biographical sketches are included in this issue.

Other areas of interest include a complete listing of society Adcom members and technical committee chairpersons. Find an area which matches your interests and get involved. The IEEE is moving to more than just electronic conference and transaction submissions. There are a host of IEEE services provided via email. Read Rosalyn's excellent summary entitled IEEE gets connected for the details. We also have our first, but hopefully not the last in a new series of recent Ph.D. dissertation abstracts.

I look forward to discussing the Magazine and other topics—my current favorite is telerobotics—with you in Atlanta and beyond. Don't forget we have two more issues to publicize your activities before the end of the year. Make a pledge to contribute to the newsletter this summer.

Bits and Pieces from the Vice-President for Technical Affairs

C. S. George Lee
Purdue University

I would like to take this opportunity to keep you informed of recent activities relating to the Society's technical affairs.

Technical Committees and their Chairpersons.

With recommendations from various AdCom members, I have nominated the following people to chair several TCs.

- Discrete Event Dynamic Systems (Chairs: Tarek M. Sobh and Kimon P. Valavanis)
- Programming Environment in R&A (Chairs: Vincent Hayward and Giuseppe Menga)
- Medical Robotics (Chairs: George A. Bekey and Russell H. Taylor)
- Mobile Robots (Chairs: Xiaoping Yun to co-chair with Yuan F. Zheng)

If you are interested in any of the activities of the above technical committees, please contact the respective Chair(s). The address, e-mail, and phone number of all the TC Chairs are listed elsewhere in this Newsletter.

Distinguished Lecturers Program of the R&A Society.

The AdCom approved allocation of \$10,000 for the Distinguished Lecturers (DL) Program for a period of two years. At the present time, a total of about 20 distinguished lecturers have been invited (see the tentative list in box).

The main objectives of the Society's DL Program are:

- 1) to foster better relationship between the Society and both local and student sections, and
- 2) to assist local and student sections in recruiting new members.

IEEE TAB New Technology Directions (NTD) Committee

The IEEE TAB formed a New Technology Directions (NTD) Committee (chaired by Martin V. Schneider of AT&T Bell Labs) a year ago. The objective of the NTD Committee is to look into new emerging technologies in each IEEE society and report the findings to the members at large either in *IEEE Spectrum* or *IEEE Institute*. The VP for Technical Affairs is working with each Chair of Technical Committees to come up

with a list of our Society's new emerging technologies. If you have developed some new emerging technologies in robotics and automation and would like to share the information with other IEEE members, please report them to the appropriate TC Chairs or to

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Guidelines for Requesting Distinguished Lecturers

- Local and student sections can select up to two Distinguished Lecturers (DLs) per year. The presidents of the local/student sections submit their application to the Program Coordinator (Prof. C. S. George Lee) of the DL Program.
- Based on the availability of funds, the Program Coordinator approves the requests.
- The DL Program pays for the travel expenses for all the DLs while the local/student section pays all the meals and accommodations for their invited DLs. If necessary, the DL Program may assist the local/student section in paying some of the meals and accommodations for the invited DLs if funds are available. Requests for additional subsidies will be considered individually.
- The invited DL plans his/her travel and requests reimbursement from the Program Coordinator after his/her visit.

Robotics and Automation Society Distinguished Lecturers

Dr. James Albus
Prof. Suguru Arimoto
Prof. George A. Bekey
Dr. Antal K. Bejczy
Dr. Brian Carlisle
Prof. Steven Dubowsky
Prof. Katsuhisa Furuta
Prof. Georges Giralt
Dr. Raymond W. Harrigan
Prof. Gerhard Hirzinger

Prof. Y. C. Ho
Prof. John M. Hollerbach
Prof. Avi Kak
Prof. Takeo Kanade
Prof. J. Y. S. Luh
Prof. Vladimir J. Lumelsky
Prof. Richard Paul
Prof. Arthur C. Sanderson
Dr. Daniel E. Whitney

1994 IEEE International Conference on Robotics & Automation

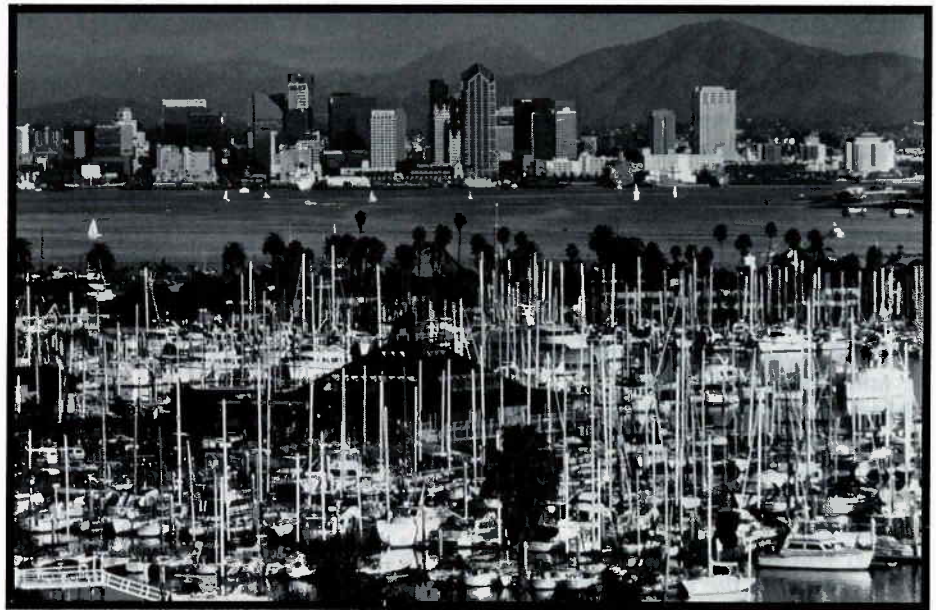
*Prof. William A. Gruver
School of Engineering Science, Simon Fraser University
General Chair*

Conference Theme: Robotics and Automation in the Service of Humanity

Major scientific and engineering accomplishments have been reported over the last decade. As the field of robotics and automation matures, the research community is now looking into the future with a renewed sense of purpose, entrepreneurship, and dedication to the enhancement of the quality of life. Intelligent robotic systems are being developed by the rapidly emerging service robotics industry. Applications of advanced automation technology are having an increasing impact on productivity in many manufacturing sectors and have become a key competitive factor in the global economy. The 1994 Conference will bring together researchers and practitioners to present the latest accomplishments and explore future directions. Special emphasis will be placed on applications and industrial case studies to help identify new "pulling forces" for research in the 21st century.

About San Diego

Located on the southern coast of California, adjacent to the Mexican border and the Baja Peninsula, the greater San Diego area has grown rapidly to more than 3 million inhabitants. 16 major airlines provide service to Lindbergh Field. San Diego is a center for high technology, R&D,



SAN DIEGO SKYLINE: Nestled between the mountains to the east and the Pacific Ocean to the west, San Diego's skyline is an impressive contrast to its natural surroundings. San Diego is the oldest and second largest city in California. PHOTO CREDIT: James Blank/San Diego Convention & Visitors Bureau

manufacturing, software companies, federal labs, and leading universities and colleges.

Average temperatures in May are 70 F (high) and 57 F (low). In addition to having possibly the most pleasant climate in the United States, San Diego is known for its universities, research laboratories, and industries, as well as fine restaurants and hotels. San Diego is serviced by most major airlines with direct flights to many international cities. It is the home of the San Diego Zoo, Old Town, Sea World, Wild Animal Park, La Jolla, and many other famous sights. Disneyland, Tijuana, and the

exotic Anza-Borrego Desert State Park are within a short drive.

San Diego Princess Resort

This hotel offers cabana (bungalow) style guest rooms. Located on Mission Bay, the resort is 7 miles from the airport and downtown San Diego. Many rooms are beach front or face tropical lagoons. Recreational opportunities include 8 tennis courts, a marina with sailboats and motorboats, volleyball, bicycle concession, 5 swimming pools, whirlpool, par course and running course, botanical walk and a mile of sandy beaches to enjoy. (*Daily rate guaranteed for 1994: \$125 single/double*).

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Submissions Deadline

1994 IEEE International Conference on Robotics & Automation

October 1, 1993

The Call for Papers will be available at the Atlanta Conference and will be published in the Summer newsletter. Contact Harry Stephanou, Program Chair, for more information.

The General Chair

William A. Gruver is professor of engineering science at Simon Fraser University in British Columbia, Canada. Previously he was director of the Center for Robotics and Manufacturing Systems at the University of Kentucky. His industrial experience includes engineering and management positions with General Electric Company, IRT Corporation, NASA, and the DLR German Space Research Establishment. He has also held faculty positions at North Carolina State University, the United States Naval Academy, and the Technical University of Darmstadt, Germany.

Dr. Gruver holds the PhD, MSEE, and BSEE degrees from the University of Pennsylvania, and the Diploma in Automatic Control Systems from Imperial College of the University of London. He is the author of 3 books and 110 journal and conference articles. His research interests include grasping by multi-fingered hands and sensor-based control with applications to manufacturing, service, and rehabilitation engineering. He is an associate editor of the IEEE Transactions on Systems, Man, and Cybernetics and an AdCom member of the SMC Society. He is a member of the editorial boards of Robotics and Autonomous Systems and the International Journal of Systems Automation. He has served as an associate editor for the Transactions on Robotics and Automation and was a founding officer of the Robotics and Automation Society.

Developing Countries Fellowships

Applications must be postmarked **October 1, 1993** for the Developing Countries Fellowships offered by the Robotics and Automation Society. The fellowships include travel assistance of \$500 and waiver of registration fees will be granted to selected applicants from Africa, Asia, Eastern Europe, and Latin America (preference given to university students).

To apply, submit a one-page letter containing: name, address, telephone and FAX numbers (if available); (2) professional affiliation and nature of work (if student, describe current level in university, major field, etc.) (3) brief description of why attendance at the conference would be beneficial to your studies and/or professional career. The letter should be sent to:

Professor George Bekey
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Univ. of Southern California
Los Angeles CA 90089-0782 USA
Tel: 213 740 7285
Fax: 213 740 7285
email: bekey@pollux.usc.edu

Maryland School Wins First National Engineers Week Future City Competition

WASHINGTON, Feb. 26 -- When asked about how they would power a city of the year 2010, seventh- and eighth-graders from Maryland's Tilden Middle School responded with a model of a city powered by hydro-electric and biomass energy sources.

On Wednesday, February 17, only hours before President Clinton addressed the nation with his vision of how America can revitalize its economy and infrastructure, students from this middle school in Rockville, Md., presented "Tilden Town," their vision of how to rebuild America's inner cities and power them more efficiently.

The Tilden students won the national finals of the first-ever National Engineers Week Future City Competition held here at the U.S. Department of Energy. Energy Secretary Hazel R. O'Leary presented the team with their award at a ceremony and press conference following the competition. The winning team consisted of Emma Lincoln, Kevin Milans and Matthew Smith; faculty advisor Mrs. Gerry Klinglesmith; and engineer volunteer Steve Nieberding. Prior to competing at today's national contest, they won the Washington regional competition.

The students' challenge was to engineer a city of the 21st century that is energy-efficient, environmentally sound, cost-efficient and people-oriented. They designed their

city on SimCity software, donated by Maxis, then used their computer blueprints to build a scale model, complete with moveable parts. They described their city's use of alternate energy sources in an accompanying essay.

The five finalist teams demonstrated and defended their project before a distinguished panel of judges, including Kenneth T. Derr, Chairman and CEO of Chevron Corporation and honorary chair of National Engineers Week; and Martha Sloan, president of The Institute of Electrical and Electronics Engineers, Inc., (IEEE) and chair of National Engineers Week. Entries were evaluated on computer design, city model, essay and presentation.

In recognition of their winning project, Tilden School was awarded a \$1,000 grant from the Engineering Foundation toward its math and science programs, a personal computer donated by IBM, and other prizes. They also received an expense-paid stay in Washington for the finals, Maxis software and another IBM computer for having won their regional competition.

The five finalist teams demonstrated their projects later that day at the National Engineers Week Evening Gala at INTELSAT headquarters in Washington. On Thursday, March 4, the Tilden team is scheduled to meet with President Clinton in recognition of its efforts to engineer a better future for Ameri-

ca's cities. Afterwards, the team's project will go on display at the Franklin Institute in Philadelphia, while the other four finalists will be exhibited at the U.S. Department of Energy.

The National Engineers Week Committee sponsored the Future City Competition in cooperation with The MATHCOUNTS Foundation and The National Science Supervisors Association. National Engineers Week, founded in 1951 by the National Society of Professional Engineers, is the only national event celebrating the engineering profession. This year, the IEEE is the lead sponsor among the week's 18 sponsoring societies, and Chevron leads 10 sponsoring corporations.

Got those empty mailbox blues?

If you have moved or changed jobs and your IEEE publications did not follow you, or if you want to order new publications or get information, contact IEEE Customer Services, Tel. (800) 678-4333 (U.S. only), (908) 981-0060 Fax (908) 981-9667 or email membership.enquiries@ieee.org. Include your full name (as it is listed on your card), your IEEE membership number, your address, and your old address. Then, describe your problem or enquiry. Allow four to six weeks for address changes.

What Do IEEE Members Want from Their Institute?

Troy Nagle
North Carolina State University
IEEE President-Elect

What can we do today to help IEEE better serve its members in the rest of this decade? Which products and services should the Institute provide to its members? What services do the members really want? Can we provide them these services and keep the member dues at current levels? These are a few of the questions that every new IEEE President faces. I will be addressing these questions during my upcoming three year term on the IEEE Board of Directors and Executive Committee.

•THE MAJOR CHALLENGE

I believe that the major challenge for IEEE is member retention. The table below summarizes the number of members in various categories that drop their IEEE membership each year:

Category (%)	Arrears
Fellows	.5
Senior Members	1.5
Members	8.
Institute Average	13.
Associates	20.
Students	25.
Recent Graduates	50.

About 30% of the students enrolled in electrical and computer engineering program join IEEE. Why do we lose half of them upon graduation? The most common reasons stated by those who drop their memberships are: Dues cost too much relative to the perceived value of membership. Many believe IEEE is solely a professional organization (versus a technical one). Others think that membership won't help them progress in their jobs. A frequent complaint is that IEEE journals are too theoretical. Many employers discourage participation because they

think participation in IEEE will take them away from their jobs. Young engineers complain that IEEE provides no services, activities, benefits, or publications for them.

If IEEE is to achieve a more prominent position in the profession, we must convince these young members to remain within IEEE. I hope to improve the Institute's ability to provide services to these young members. Here are a few of my personal goals for the period 1993-1995.

•PERSONAL GOALS

- Create a new perception among students that IEEE is essential for career success. This is the most important thing I could accomplish during my term of office.

- Increase emphasis on Continuing Education at all levels in the Institute. By providing a greatly expanded selection of educational materials, IEEE members will be able to keep their job skills at peak performance levels. Keeping our members competitive in the job market is a high priority.

- Make the Section/Chapter a "continuing education" group in the eyes of IEEE members. Our Section/Chapters have been underutilized as a resource in achieving continuing education for our members.

- Make IEEE Press the publisher of choice for IEEE-member authors. A strong IEEE Press will bring many new books to our membership at discounted prices.

- Increase IEEE entity involvement in environmental issues. There is international concern for a clean environment among IEEE members. We should join in efforts to make our products and service environmentally safe.

- Improve mechanisms to measure member satisfaction. The Institute does not have effective methods to measure member satisfaction. If

members are dissatisfied, they stop paying their dues. We must develop methods to reach these members before they drop out of the organization.

•PRODUCTS AND SERVICES

In order to provide better service to our members, I have been investigating several possible new products and services.

•Continuing Education

In the Continuing Education area, we are considering having IEEE develop under contract a series of new courses for major industries. These courses would be made available to all IEEE members. Another initiative is underway to find ways for IEEE and the National Technological University to team in joint continuing education courses. NTU has an international satellite broadcast network to more than 450 locations in companies and universities.

•Member Networks

Another idea under exploration is the concept of establishing new entities within the Institute (jointly sponsored by TAB and USAB) that IEEE members can join, similar to our existing Technical Societies. For example, we could create a Consultants Network, an Entrepreneurs Network, an Inventors Network, a Young Engineers Network, or a Retired Engineers Network. Other examples might be design and applications entities such as a Digital Design Group, an Analog Circuits Group, or a Quality Control Group.

•CD-ROM Products

The Technical Activities Board and its Societies are developing new CD-ROM products such as conference proceedings, collections of past publications, and technical compendia. Another idea under consideration is the establishment of IEEE Member/Expert Databases. The

AdCom Notes

David E. Orin
The Ohio State University
R & A Society Secretary

The Administrative Committee met in Tucson, Arizona on December 14, 1992 and conducted business of importance to the Society.

President T.J. Tarn is serving in his second year as President of the Society in 1993. The four amendments to the Constitution, including the two-year term for the Society President, received all final approvals to become effective on November 1, 1992. President-Elect Richard D. Klafter will then serve a two-year term as President beginning in 1994.

Professor T.C. (Steve) Hsia was elected to serve as Vice President for Finance for the Society, effective January 1, 1993. Much appreciation was expressed to Professor Richard D. Klafter for his long years of dedicated service to the Society in this capacity. Professor Toshio Fukuda and Dr. William Hamel will co-chair the Meetings Committee previously chaired by Professor Hsia. Requests for co-sponsorship of conferences, workshops, and other meetings may be directed to the AdCom through these individuals.

Congratulations were extended to the six new members of the AdCom whose three-year terms begin on January 1, 1993. Those elected were Alan A. Desrochers, Andrew A. Goldenberg, Pradeep K. Khosla, John Y.S. Luh, Howard Moraff, and David E. Orin.

The final steps in the Distinguished Lecturers Program are being taken so that it may begin in 1993. Further information may be obtained from Professor George Lee, the Vice President for Technical Affairs.

Preparations continue to be made for the 1993 Conference under the leadership of Professor Wayne Book, the General Chairman, and Professor John Y.S. Luh, the Program Chairman. The Conference is set for May 2-6, 1993 in Atlanta. The general sessions will be held Monday through Wednesday while the workshops and tutorials are scheduled for Sunday and Thursday. The AdCom voted to provide diskettes to the Conference participants which will contain the table of contents for the Proceedings and abstracts & bibliographies for each of the papers. This will be in addition to the printed Conference Proceedings.

Advance preparations are also being made for the 1994 and 1995 Conferences. The 1994 Conference, under the leadership of Professor William Gruver as General Chairman and Professor Harry Stephanou as Program Chairman, will be held May 8-13, 1994 in San Diego. The 1995 Conference, under the leadership of Professor Toshio Fukuda as General Chairman and Professor Suguru Arimoto as Program Chairman, will be held May 22-27, 1995 in Nagoya, Japan.

The AdCom voted to transition from a Society Newsletter to a Magazine. The scope of the Magazine will bridge the gap between the Transactions and trade publications. Dr. Michael Leahy, the Editor of the Newsletter, will work with Rosalyn Snyder, the Managing Editor of the Newsletter, and Professor Robert Kelley, the Chairman of the Publications Committee, to develop the proposal for approval from the IEEE.

The next meeting of the AdCom is May 2, 1993 in Atlanta. Any interested society member is invited to attend.

IEEE President-Elect Troy Nagle Seeks Feedback From Members (from p. 9)

Technical Societies would compile the materials for the databases and the IEEE would publish the materials and make them available to industrial and other professions, such as medical and legal organizations.

•Student Services and Programs

For students and recent graduates, how about their own technical compendia, case studies, and design projects, edited by students and recent graduates, and distributed on electronic media? We need a large

variety of international design contests sponsored by major industries. We might also create Student Enterprise Clubs in association with the Entrepreneurs Network mentioned above. Another important student program to be explored are IEEE Student Symposia conducted on University campuses. These Symposia would be an expansion of the existing S-PAC concept to include involvement of the other major boards of the Institute.

•Seeking Member Feedback

I have suggested a few new programs in this article. What are your ideas? What do you think of the suggestions above?

How can IEEE best serve its members? Send your comments to: H. Troy Nagle, IEEE Headquarters, 345 E. 47th St., New York, NY 10017.

1993 Robotics and Automation Society IEEE Fellows

Dr. David Grossman
IBM T.J. Watson Research Center



For contributions to
robotics and automa-
tion

David Grossman received the BA, MA and Ph.D. degrees in Physics from Harvard. After teaching at Princeton and working on storage rings in Italy, he joined IBM Research in 1970.

Dr. Grossman has made technical contributions to the technology and application of programmable robots for assembly and surgery, high level robot programming languages, smart teaching, robot calibration, automatic orientation of mechanical parts, methods for clamping workpieces, 3-D solid geometric modeling, graphical simulation of robots, analysis of tolerancing in mechanical assembly, mobile robot traffic control, and image processing. He spent two sabbaticals at Stanford, working on robotics and semiconductor equipment automation. He has served on many government, industry, university, and editorial panels, and has 10 patents and over 60 technical papers. In 1976, he demonstrated that a programmable robot could reliably insert electronic components on cards. In 1978, he led the installation of the first programmable industrial robot in IBM's factories, for testing backplane wiring, a data-directed application that featured 2-arms, collision avoidance, and self-calibration. Technology developed by Dr. Grossman and his colleagues was the basis for robotic systems marketed by IBM, starting in 1981.

Dr. Grossman has also managed automation research on CAD/CAM, CIM, plant scheduling and control, and vision, as well as Artificial Intelligence research on logic programming, knowledge representation, and natural language processing.

Dr. David E. Orin
The Ohio State University



For contributions to the
computation of robot
kinematics and dynamics

David E. Orin received his B.S.E.E., M.S., and Ph.D. degrees in Electrical Engineering from The Ohio State University, Columbus, Ohio in 1972, 1973, and 1976, respectively. From 1976-80, he taught at Case Western Reserve University, Cleveland, Ohio in the Department of Electrical Engineering and Applied Physics. Since 1981, he has been at The Ohio State University, where he is currently a Professor of Electrical Engineering. He developed courses in robotics at both CWRU and OSU. Dr. Orin has made technical contributions in several areas of robotics: computational kinematics and dynamics, parallel architectures, walking machines, and enveloping grasping systems. His early contributions in kinematics and dynamics include efficient methods for computing the Jacobian, inverse dynamics, and forward dynamics. At OSU, he led an NSF project to develop parallel algorithms and architectures for robot control. He was a major contributor at OSU to DARPA's Adaptive Suspension Vehicle demonstration project of a walking machine. Recently, he co-developed DIGITS, a multi-finger grasping system to investigate power grasping. He has contributed over 75 papers on these research topics, and has traveled to a number of countries to present his work. Dr. Orin is the Secretary of the IEEE Robotics and Automation Society. He is a Contributing Editor with *Robotics Review* from the MIT Press. He is also a member of Sigma Xi, Tau Beta Pi, and Eta Kappa Nu.

Dr. John Baillieul
Boston University

For contributions to nonlinear control theory, robotics, and the control of complex mechanical systems.



John Baillieul's research deals with robotics, the control of mechanical systems, and mathematical system theory. His Ph.D. dissertation, completed at Harvard University under the direction of R.W. Brockett in 1975, was an early work dealing with connections between optimal control theory and what has recently been called "sub-Riemannian geometry." After publishing a number of papers developing geometric methods for nonlinear optimal control problems, he turned his attention to problems in the control of nonlinear systems modeled by homogeneous polynomial differential equations. Such systems describe, for example, the controlled dynamics of a rigid body. His main controllability theorem applied the concept of finiteness embodied in the Hilbert basis theorem to develop a controllability condition which could be verified by checking the rank of an explicit finite dimensional operator. During the mid 1980's, Baillieul collaborated with M. Levi to develop a control theory for rotating elastic systems. Recently, he has written a number of papers on motion planning and control of kinematically redundant manipulators, and he has become interested in problems associated with anholonomy in planning motions for robots which have elastic joints and other components which store energy. He has also become interested in applying the methods of dynamical systems theory and classical geometric nonlinear control theory to control super-articulated mechanical systems having more degrees of freedom than control inputs.

John Baillieul holds a joint appointment as Professor and Chairman of Aerospace/Mechanical Engineering and Professor of Manufacturing Engineering at Boston University, Inc. Professor Baillieul has been an active member of the IEEE Control Systems Society for many years. He is currently a member of the editorial boards of the *Journal of Bifurcation and Chaos in Applied Science and Engineering*. He is Editor-in-Chief of the *IEEE Transactions on Automatic Control*.

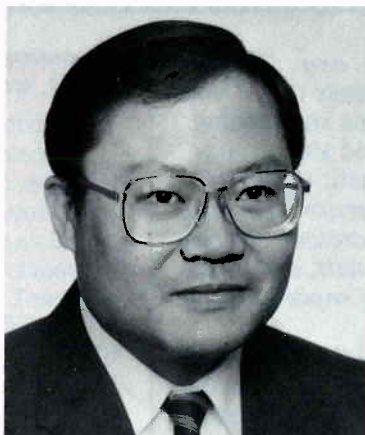
Dr. J. Thomas Cain
University of Pittsburgh

For leadership and contributions to computer science and engineering education.



J. Thomas Cain has been a member of the electrical engineering faculty at the University of Pittsburgh since 1966. His current research interests are in the areas of real time systems and educational systems, particularly techniques for properly integrating CAD/CAE concepts into undergraduate programs in electrical engineering, computer engineering, and computer science. Dr. Cain chaired the joint IEEE-CS/ACM task force that led to the creation of the Computing Sciences Accreditation Board (CSAB). Under his leadership CSAB became recognized by the US Department of Education and the Council on Post Secondary Accreditation (COPA). Dr. Cain, along with Dr. Taylor Booth, drafted the original computer engineering program criteria for the Accreditation Board for Engineering and Technology (ABET), and later led the effort to revise the original criteria to those in current use. He was the editor of the "1977 Model Curriculum in Computer Science and Engineering" report, the Computer Society project that first defined comprehensive curricula for this emerging discipline area. He co-chaired the CS project that resulted "1983 Model Curricula in Computer Science and Engineering". Dr. Cain was one of the Project Directors of the National Science Foundation sponsored Digital Systems Education (DISE) project which utilized academic, industrial, and governmental leaders from throughout the nation to develop prototype educational materials for teaching digital systems. Most recently, he served three years (1990-92) on the IEEE Board of Directors, including two years as Vice President for Publication Activities (1991-92). He is currently a candidate for 1994 President Elect of the IEEE.

Dr. C.S. George Lee
Purdue University



For contribution to computational algorithms and architectures in robot kinematics and dynamics, and for leadership in robotics education

C. S. George Lee received the B.S. and M.S. degrees in electrical engineering from Washington State University in 1973 and 1974, respectively, and the PhD degree from Purdue University in 1978.

In 1978-1979, he taught at Purdue University, and in 1979-1985, at the University of Michigan. Since 1985, he has been with the School of Electrical Engineering, Purdue University, where he is currently Professor of Electrical Engineering. His current research interests include computational robotics, intelligent robotic assembly systems, and neural-network-based fuzzy systems.

Dr. Lee was an IEEE Computer Society Distinguished Visitor in 1983-1986, the Organizer and Chairman of the 1988 NATO Advanced Research Workshop on Sensor-Based Robots: Algorithms and Architectures, and the Secretary of the IEEE Robotics and Automation Society in 1988-1990. Currently, he is Vice-President for Technical Affairs of the IEEE Robotics and Automation Society, and an Associate Editor of the International Journal of Robotics and Automation. He is a co-author of *Robotics: Control, Sensing, Vision, and Intelligence* (McGraw-Hill), and a co-editor of *Tutorial on Robotics* (Second Edition), (IEEE Computer Society Press). He is a member of Sigma Xi and Tau Beta Pi.

Prof. Nukala Viswanadham
Indian Institute of Science

Citation: For contributions to the modeling and performance of analysis of flexible manufacturing systems.
(We regret that further information was not received in time for publication)

Dr. Robert F. Stengel
Princeton University



For contribution to the analysis and design of aerospace control systems

Robert Stengel is Professor of Mechanical and Aerospace Engineering at Princeton University, where he directs the Topical Program on Robotics and Intelligent Systems and the Laboratory for Control and Automation. Prior to his 1977 Princeton appointment, he was with The Analytic Sciences Corporation, Charles Stark Draper Laboratory, U.S. Air Force, and National Aeronautics and Space Administration. A principal designer of the Project Apollo Lunar Module manual attitude control logic, he also contributed to the design of the Space Shuttle guidance and control system.

Dr. Stengel received degrees from M.I.T. (Aeronautics & Astronautics, S.B., 1960) and Princeton University (Aerospace and Mechanical Sciences, M.S.E., M.A., Ph.D., 1965, 1966, 1968). He is a Fellow of the IEEE, an Associate Fellow of the AIAA, and a Member of the SAE Aerospace Control and Guidance Systems Committee. Professional positions include Associate Editor at Large of the IEEE Transactions on Automatic Control, North American editor of the Cambridge University Press Aerospace Series, Member of the Journal of Micromechanics and Microengineering Editorial Board, and Member of the Program Council for the New Jersey Space Grant Consortium. He was Vice Chairman of the Congressional Aeronautical Advisory Committee and Chairman of the AACC Awards Committee, and he has served on numerous governmental advisory committees.

Dr. Stengel's current research focuses on system dynamics, control, and machine intelligence. He teaches courses on control and estimation, aircraft dynamics, space flight engineering, and aerospace guidance. Dr. Stengel wrote the book, *STOCHASTIC OPTIMAL CONTROL: Theory and Application*, (J. Wiley & Sons, 1986).

The IEEE gets connected

Rosalyn Snyder

E-mail is a wonderful thing, combining the civility of letters and the convenience of telephones. The IEEE is in the midst of an ambitious effort to utilize e-mail technology to the maximum.

A large part of the program is already in place. Although some of the services advertised are not yet completely on line, the directories are not complete, and there is sometimes a delay in response, but on the whole it is working very well.

You can use the IEEE e-mail system to contact other IEEE members and staff, to obtain information, and to request services such as ordering publications.

A new service, ASKIEEE, enables members to order copies of individual articles published by the IEEE and others. Orders are delivered by mail or fax.

The IEEE e-mail system has been in operation since 1990. Most IEEE staff members in New York, Washington and Piscataway, and about 2000 volunteers have been assigned mailboxes. There are also special service mailboxes which members can query to order publications, get help with delivery problems, and obtain information. The aliases follow the format

[i].[name]@ieee.org. This format has the advantage that if you know someone's name and nothing more, you have a good shot at successfully sending email! (If you're sending "blind", increase your odds by trying the alias addresses with one and two (or more initials, e.g. r.snyder@ieee.org and r.g.snyder@ieee.org))

Mail received at the IEEE mailbox is immediately forwarded to the addressee's "home" email address at his/her business or institution as long as it is part of an e-mail system that has an Internet gateway. The forwarding system is so smooth that recipients are often unaware that the mail was sent via ieee.org.

Volunteers can update their addresses by email, and everyone is sent update forms annually so that the forwarding addresses can be kept as accurate as possible. This can be a great help when your system supervisor assigns new email addresses to everyone the week after you have attended a conference and distributed two hundred business cards with the old address. Active volunteers especially are encouraged to apply for IEEE aliases, but any IEEE member may request an alias and be included in the directory. The response has been "very positive", according to the auto-response message I received, so it may require more than the promised 24 hours to receive your alias and directory listing, so be patient. You will receive a test message with your alias.

To receive an electronic directory of individuals on the system, mail info.directory@ieee.org. Many volunteers without Internet access can get on the system through Comppmail. Comppmail is a contract between the IEEE Computer Society and U.S. Sprint. Users may also access e-mail through MCI Mail or Compuserve or any commercial vendor with a gateway to the Internet. The volunteer needs a personal computer, modem and some software. There are no guest accounts.

Try it, yourself!

To be listed on the IEEE e-mail directory and obtain an IEEE alias, send a message with the following information to aliases@ieee.org

- (a) your e-mail address
- (b) your LAST name
- (c) your FIRST name and initial
- (d) your day-time phone number
- (e) your FAX number (if available)
- (f) your IEEE member number (If you are a non-member volunteer, e.g. working on a Standards group - please ask your group chair, who will be an IEEE member, to process your request)
- (g) your current major IEEE volunteer activity involvement (committee positions, etc.)

You don't have to be "in the system" to use it. Here's how.

info.info@ieee.org

Mail to this alias gets you a list of about 71 auto-response text files. If an e-mail message (not really a message, but a request using a message format) is sent to an alias that begins with "info", the message content is discarded and a prewritten text file is automatically returned to the sender.

For example a message to email.guide@ieee.org responds with the latest version of the IEEE E-mail guide.

info.service@ieee.org

Mail to this alias prompts a list of the services provided by email. For instance, if your renewal check was cashed and you received a second bill, send mail to membership-inquiry@ieee.org, and it will be forwarded to a person who can help you straighten it out! The list includes the 5 directory aliases for volunteers, staff, sections, branches, and societies.

Bob Alden of McMaster University is chair of the IEEE Electronics Steering Committee. Send comments to him at r.alden@ieee.org. Thanks to IEEE staffer **Jayne Cerone**, who provided details on the IEEE email system.

UseNet IEEE Newsgroups

There is as yet no general IEEE bulletin board. However, If you have access to UseNet newsgroups, there are 17 "newsgroups" which have information on specific topics. A single information item could be added to the directory of a number of these "newsgroups." The IEEE-related newsgroups are:

ieeenet.news.newusers

ieee.rab.general	ieee.pcfnf
ieee.announce	ieee.tab.announce
ieee.regional	ieee.rab.announce
comp.org.ieee	ieee.tab.general
ieee.usab.general	ieee.usab.announce
ieeenet.test	ieeenet.netlog
ieee.config	ieeenet.tcos
ieeenet.logs.zeus	
ieee.general	

News from Industry

The following items are taken from Robot Times, the newsletter of Robotics Industries Association (RIA) RIA is a major trade association for robot manufacturers and users,

International Market Update: Taiwan

Taiwan, is the fastest growing market for industrial robots, according to the latest annual statistics report issued by the International Federation of Robotics.

The new IFR report, which provides details on the use of robots through the end of 1991, shows that the robot population in Taiwan grew by 31% in 1991. This follows a 34% increase in 1990, bringing the total number of robots in Taiwan to 1,688.

The largest end user is the motor vehicle industry, accounting for 55% of the installed base. Electrical machinery is second at 12%.

The leading application area is welding (57%), trailed by assembly (15%).

More information on Taiwan's use of robots and comparisons to some 20 other nations is included in the 1991 *International Robot Statistics*, available from RIA headquarters.

Revitalizing US Manufacturing Strength

The Robotic Industries Association, RIA, has joined the debate in the U.S. on how to revitalize the nation's industrial base.

At the recent annual conference of the National Coalition for Advanced Manufacturing, RIA president Brian Carlisle has identified four steps he called crucial to stimulate U.S. manufacturing

- Public support by government and business leaders of the the importance of manufacturing in the United States
- Implementation of the manufacturing education infrastructure programs outlined in the Clinton/Gore document: "Manufacturing for the 21st Century: Turning Ideas into Jobs";
- A targeted investment tax credit to stimulate investments in production equipment; and
- Improved access to capital for small and medium-sized businesses in the U.S.

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IEEE can be the *single* most vital source of technical information and professional support to you throughout your working career. No doubt, you're already established in your field. Now gain that competitive edge. Become the best informed—an IEEE engineering/scientific professional.



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Engelberger Award Nominations Sought

Nominations are now sought for the 1993 Engelberger Robotics Awards, sponsored by the RIA. The awards honor outstanding contribution in the areas of application, education, technology development, and industry leadership. Official nomination forms are available from RIA Headquarters. All nominations must be received no later than August 31, 1993.

Contact: Jeffrey Burnstein, Editor
900 Victor's Way
PO Box 3724
Ann Arbor MI 48106
Tel: 313 994 6088
Fax: 313 994 3338.

New Products

A British company, Robot Simulations Ltd., has released a software package it advertises as a cost effective alternative to workstation-based simulation of industrial robots. The software, Workspace3, runs on standard PCs. It is menu driven, mouse-controlled and of Super-VGA capability and it offers Constructive Solid Geometry. Errors are automatically checked so that neither the displacement nor the velocity limits of the joints are inadvertently exceeded by the user.

Workspace3 has a library of over a hundred robots. It can show a robot tracking from virtually any angle, and can depict up to ten robots working different tracks on the screen at any one time. It is compatible with industrial robotic languages such as Karel and Arla.

For more information, contact Roger Verrall, Robot Simulations Ltd., Lynn Business Centre, Lynwood Terrace, Newcastle Upon Tyne, NE4 6UL, England. Tel: 091 273 2233; Fax: 091 226 0876.

Product announcements are for information only and do not imply endorsement by the IEEE or the Robotics and Automation Society. Send new product announcements to the editor.

RIA Calendar

- **Robotics in Pharmaceutical Operations: June 9, 1993.** Secausus NJ (Two-hour workshop during ISPE Expo Plus! Sponsor: RIA Focus: State of theArt developments in the use of robots in pharmaceutical operations.
 - **Robots in Food Service: Current Applications, June 22, 1993.** Las Vegas, Nevada. (during American Society for Hospital Food Service Administrators Conference.) Sponsor: National Service Robot Association. Focus : Hospital food service applications.
 - **Automated Vision in Semiconductor Manufacturing.** July 20, 1993, San Francisco. (Day long seminar during SEMICON WEST) Sponsor: Automated Imaging Association (AIA). Focus: Emerging trends in the use of vision in the semiconductor industry, technical considerations of incorporating vision, and a demonstration of practical vision tools.
 - **Getting Started with Machine Vision.** September 7, 1993, Boston (Half-day seminar during SPIE Optical Tools Conference) .Sponsor: AIA. Focus: Key issues involved in initiating a machine vision application.
- For more information, contact the RIA at the address on p. 15.

Robotics & Automation Society Newsletter Editorial Policies

The IEEE Robotics and Automation Society Newsletter publishes news items, letters, and reports on conferences, research institutes, and work in progress. The editor reserves the right to solicit technical reviews and to reject any contribution which is inappropriate for this newsletter. Announcements for noncommercial scholarly conferences, workshops, etc. will be published gratis in our Calendar as space is available with priority given to events sponsored by the IEEE Robotics and Automation Society.

For-profit short courses and seminars may be advertised at our standard display rates.

For more information about advertising in the newsletter or the new *Robotics and Automation Society Magazine*, please contact

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919 766 6210
roz@relito.medeng.wfu.edu

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IEEE Robotics and Automation Society Email Directory

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David Stanton	University of Surrey, UK	mes2ds@surrey.ac.uk	(44) 483-306039

From the Managing Editor:

Telephone service in western North Carolina was disrupted for several days in midMarch, and I was unable to receive incoming calls and email or to send or receive faxes. My apologies to anyone who was inconvenienced. With the institution of the IEEE email system, it seems our email directory is now somewhat redundant. We encourage you to obtain an alias and listing with the IEEE (see article on p.15)

Rosalyn Snyder

Intelligent Robot Laboratory, University of Tsukuba, Japan

Shooji Suzuki

Because experiments play a very important role for evaluation in robotics, we have designed and implemented a mobile robot named *Yamabico* as a platform for experiments. Controller architecture and software constitution are among the research topics involved in the development of a platform robot.

Our key interest is to realize an autonomous behavior of mobile robots in the real world. For this purpose we are researching various topics; sensing (ultrasonic, laser, vision), motion control, programming language and tools, position estimation technique, map representation and generation, path planning and navigation behavior, and cooperation by multiple robots. Products resulting from research are mounted on our robot system and evaluated. Yamabico (an autonomous mobile robot):

Yamabico is designed as a platform for research in mobile robots. It is a self-contained robot which has everything in its body and can move without cables to supply electronic

power and information. The basic design of Yamabico includes 2 DC motors and 2 casters for locomotion, 4 directional sonars, a dedicated bus system, controller circuit boards connected to the Yamabico-bus, and DC battery.

Currently we have 12 Yamabico robots in the laboratory. Each robot may have a special device or equipment on the basic constitution, and used for the specified research, for example, laser range finder system, ultrasonic sensor system, motion control method, and so on.

Figure 1 shows three Yamabico robots. The left one has a new sonar system on the top and others have laser range finder system on the top.

The controller architecture of Yamabico is designed based on functional distribution and decision-making centralization. Each sensing and locomotion function of the robot is modularized and controlled by individual processor in this architecture.

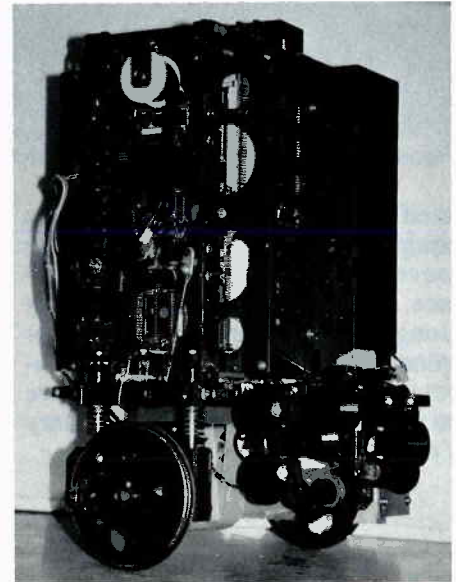


Figure 2: Yamabico Kulal

The basic Yamabico has 3 individual controller circuit boards for sonar, locomotion and decision-making. Other controller boards have been designed and developed for laser range finders, voice synthesizers, and inter-robot radio communication.

Yamabico robots are used not only in our laboratory and Meisei University, but also in other research institutes: Tokyo University, Kyoto University, Meiji University, Utsunomiya University, Keio University, SONY Co., IBM Tokyo Research Laboratory, and several others.

A wheeled balancing robot:

A Yamabico robot named Kulala (Figure 2) was designed as a self-contained wheeled inverse pendulum type mobile robot. The basic constitution of Yamabico robot has two wheels and two casters, but this robot has only just two wheels driven by a DC motor. It can keep its balance by

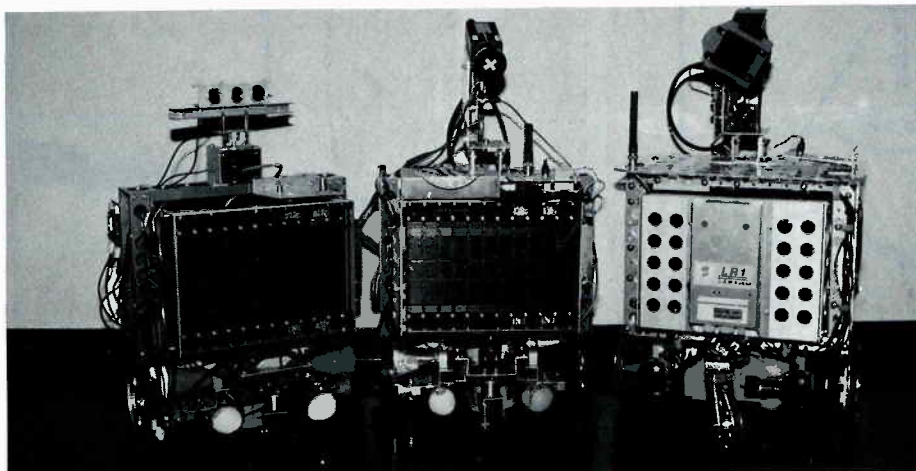


Figure 1: Yamabico robots

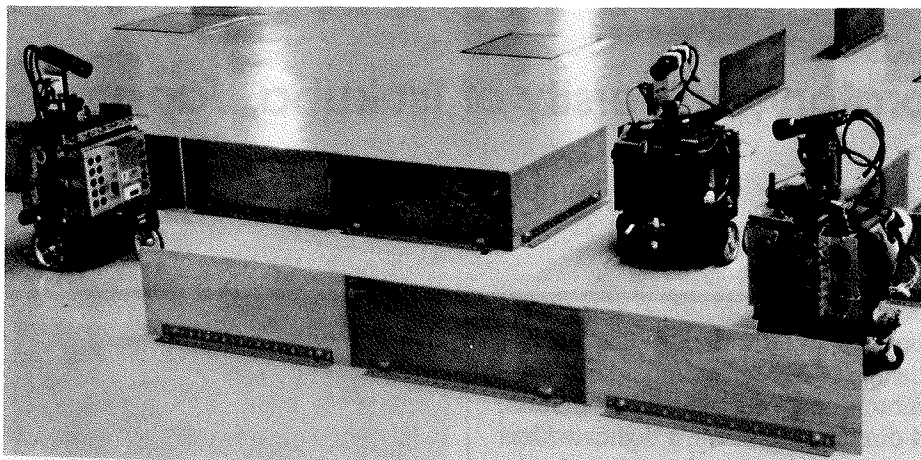


Figure 3: Cooperation by three Yamablicos

itself without the assistance of the equipments on the ground, and it can move on a flat two-dimensional surface, keeping its balance by going along the given straight trajectory or spinning at the given point. This robot potentially has an ability to move on rougher grounds than an ordinary Yamabico robot.

Inter-robot radio communication system:

CAR-Net2 has been designed and implemented for inter-robot communication. It is designed as a token ring network. Only one token exists in the network, and it is passed among the robots in the network. One robot can send or broadcast information to another when it has the token, and it

passes the token to another after sending or broadcasting. This network system is designed so that every robot can join or quit at any time, and the case of sudden disappearance of one robot in the network is treated. The basic function of this network system is to realize cooperation by multiple robots.

Cooperation by multiple robots:

Collision avoidance among the robots is a typical problem in multiple robots. An autonomous mobile robot works for its own purpose autonomously, and collision avoidance is also solved autonomously by each robot facing a collision situation. Each robot needs to know other robots' position in this case, but sensor systems on the robot can't provide enough information to know other robots' position. For this reason the CAR-Net2 system has been selected to enable the robots to exchange knowledge of their positions.

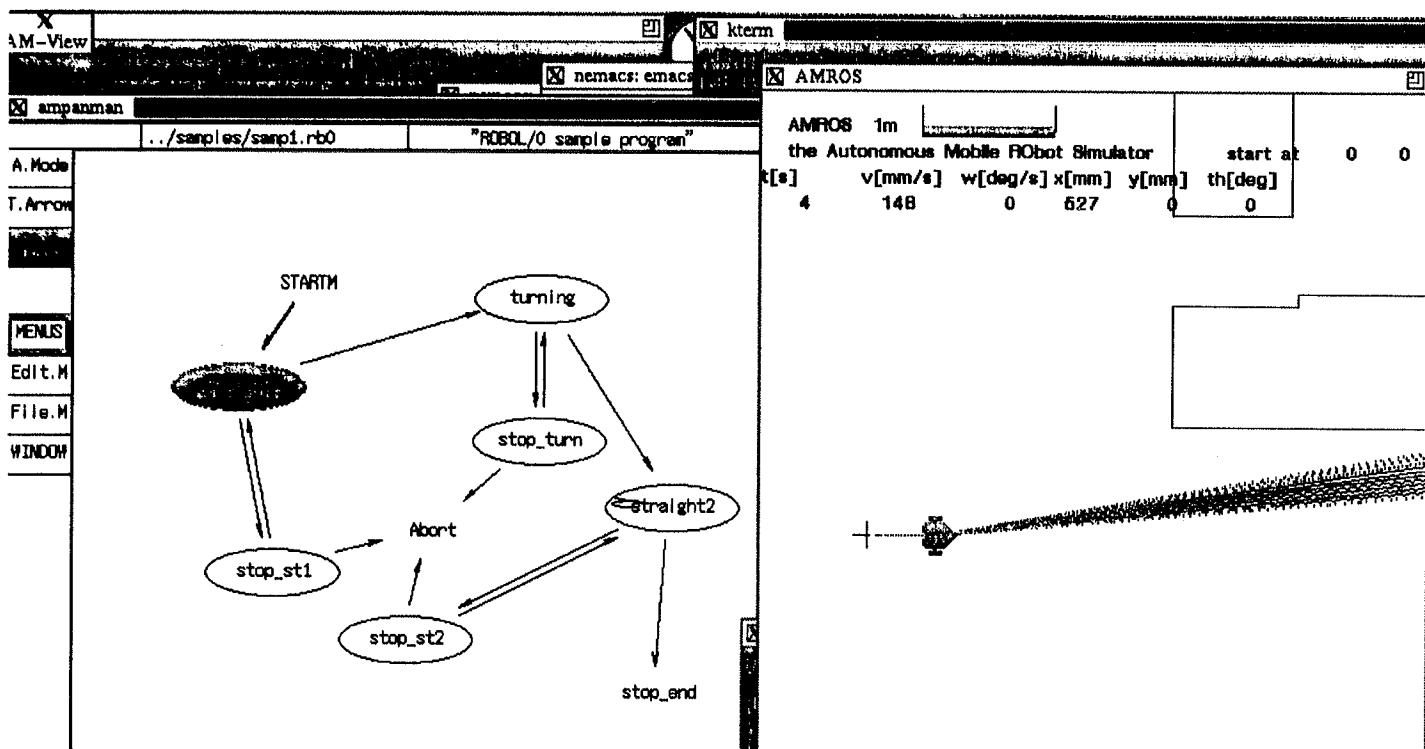


Figure 4: Software tools (Monitor and Simulator)

Intelligent Robot Laboratory
University of Tsukuba
Tsukuba, 305 JAPAN
Director: Prof. Shin'ichi Yuta

The intelligent autonomous mobile robot project at the University of Tsukuba was started by Prof. Kanayama (currently at Naval Postgraduate School, USA) in 1975. After he left the university at 1984, Prof. Yuta has continued the project with Prof. Iijima (currently with Meisei University, Japan) and several related institutes and companies. This year, eight postgraduate students, three undergraduate students, and one research associate, Dr. Oya, who joined this April, are working on the topics relating to autonomous mobile robots.

The basic strategy of collision avoidance is that one robot gives way to another robot. The robot giving way is the one which first detects the collision case: it suspends its job and gives way autonomously not to disturb another robot. We call it modest cooperation. The problem in the modest cooperation is the possibility of a deadlock situation. In that case each robot does not make its own decisions. Instead one robot is selected as a leader and decides the behavior of all the concerned robots.

The experiment is done by three Yamabico robots with a CAR-Net2 system (Figure 3).

A new sonar system

Sonar is easy, cheap and useful for sensor system of mobile robots, but it has low resolution on the lateral line because the ultrasonic beam width is very wide (10 degrees at least). We are designing a new sonar system with one transmitter and a pair of receivers to solve this problem. This sonar system can measure inclination angle of walls. The implemented sonar system can be seen on the left robot in Figure 1.

Software systems

Programming method and language

Because a behavior program of a mobile robot has different features from conventional computer programs, the programming method and tools should be designed considering such features. An action mode representation is introduced for analyzing and representing a mobile robot's behavior. An action mode is defined as a

single motion unit of a robot's behavior to represent a sensor-based action. A programming language ROBOL/O has been designed and implemented to control a mobile robot's behavior based on the action mode representation.

Simulator

Experiments using a real robot in the real environment may be also hard to achieve. Therefore the verification of a robot's behavior using

computer simulation is useful. Simulation provides not only fast execution of the experiment, but also an efficient programming environment. The autonomous robot simulator consists of many simulators which simulate the interaction between the environment and sensors/actuators of the robot. A synchronization mechanism is achieved by ROBOL/O language.

Programming tools

The Action Mode Representation Converter (AMRC), the Action Mode Transition Monitor (AMTM), and the Action Mode Transition Tracer (AMTT) have been designed as programming tools specialized for problems in the robot's programming. Figure 4 shows the Action Mode Transition Monitor (left) and the simulator system (right). These tools are used for monitoring program execution in real time. The diagram displayed on the AMTM is a robot's behavior analyzed by using the Action Mode Representation.

Academic Hurdles

Kinder Gentler Rejections

For writers only -- every writer has received rejection slips; too many of them for most. *The Financial Times* has quoted the "mother of all rejection slips", allegedly translated from a Chinese economic journal. It goes like this:

We have read your manuscript with boundless delight. If we were to publish your paper, it would be impossible for us to publish any work of lower standard. And as it is unthinkable that in the next thousand years we shall see its equal, we are, to our regret, compelled to return your divine composition, and to beg you a thousand times to overlook our short sight and timidity.

This was contributed by Dmitry Kaplan who gleaned it from the net.news.

If Aesop Had Gone to Grad School

As I was walking through the woods I saw a rabbit lugging a laptop. To my amazement, the rabbit walked right up to a fox.

"Fox," he said, I am writing the first chapter of my dissertation on how rabbits devour foxes."

"That's ridiculous," said the fox.

"Come into my hole and I'll prove it," said the rabbit.

The fox followed the rabbit into his hole. Shortly afterwards, the rabbit came out alone, with a satisfied smirk on his face.

He then accosted a wolf.

"Wolf," he said. I am writing Chapter 2 of my dissertation, where I describe how rabbits devour wolves."

"Go away," snorted the wolf. "That's a totally indefensible hypothesis. Where's your intellectual honesty?"

"Come into my hole and see," replied the rabbit.

The wolf squeezed himself down into the hole after the rabbit. A few minutes later the rabbit hopped out alone, smiling broadly and grasping a diploma in his paw.

Unable to stand it, I poked my head down into his hole. Despite the darkness I was able to see, sitting amid the bloody bits and pieces of the fox and wolf, a huge and ferocious lion, licking his chops.

Moral: Who your advisor is makes all the difference
Thanks to Bill Chimiak.

Control Of Bracing Micro/macro Manipulators

Jae Young Lew

This research proposes a bracing strategy for micro/macro manipulators. The bracing micro/macro manipulator can provide advantages in accurate positioning, large workspace, and contact-task capability. However, in exchange for improvement in performance, one must accept the complex control problem along with the complex dynamics. The goal of this research is to develop 1) an efficient method of dynamic modeling of micro/macro systems and 2) a control strategy for a bracing manipulator which makes multiple contacts with the environment.

In general, a micro-arm is mounted on the end of a macro-manipulator. The macro-manipulator would carry the micro-arm to the place of interest in a large workspace. Then the micro arm would perform fine motions. One of the inherent problems with this serial configuration of micro/macro manipulators is the structural flexibility of the macro-manipulator. Bracing micro/macro manipulators can be one effective way to reduce or damp out its structural vibration. For example, the manipulator would brace against a stationary frame, and the end effector would perform fine motion control just as a human braces the wrist for accurate writing. By forming a closed kinematic chain, bracing will stiffen its structure and secure the end point positioning.

It is essential for a control designer to understand the dynamics of the coupled small and large manipulators. It is not straight-forward to obtain the dynamic equations of motion for the micro/macro manipulators including the structural flexibility. Moreover, it is a time consuming and repetitive procedure to derive each dynamic equation for various combinations of modular

small arms and a long reach manipulator.

An efficient method of deriving the equations of motion has been developed when two robotic systems are serially connected. Instead of computing the coupled dynamics directly, this work identifies the coupling dynamics between two manipulators first and constructs overall dynamic equations from previously known equations of each manipulator. This approach will reduce the number of computations and show the structure of the coupling dynamics between two arms. The analysis assumes that the micro-arm is rigid and the macro-manipulator has flexible links. The proposed method is coded in Mathematica for symbolic computation. A case study shows not only simplicity of derivation, but also reduces the computation time by at least one-third compared to the conventional derivation which is direct bottom to top computation.

Bracing requires a special type of control strategy due to its complex constrained dynamics. This research generalizes the bracing arm control problem as a hybrid control of flexible manipulators with multiple contacts. For example, the end effector works against a workpiece, and the other part of the manipulator may brace against a stationary frame. Then, the manipulator should be able to control the position/force not only at the end effector, but also at the bracing point. This requires hybrid control of multiple contacts with the environment.

This research developed a hybrid position/force controller for flexible link manipulators which make contact with environment at more than one point. First, a mathematical formulation of the constrained dynamics is obtained. Their dynamics are transformed into two

subspaces such as constrained and constraint-free spaces using the singular value decomposition of constraint equations. The force and position controllers are developed based on the orthogonality of these two subspaces. This work has been developed in a generic form for broad application. Theoretical study proves its asymptotic stability and adds a robust controller in the presence of uncertainty in system modeling.

Experimental manipulators, RALF and SAM, were constructed to serve as a test bed for evaluating the proposed analytical work and to suggest uncovered research issues for the application of micro/macro systems. The proposed modeling method and control algorithm are implemented on RALF and SAM. The experimental results show promising feasibility for real world application. Also, it is demonstrated that bracing could be an effective strategy to damp out the structural vibration.

Jae Young Lew
George W. Woodruff School of
Mechanical Engineering
Georgia Institute of Technology.
Advisor: Wayne Book
February 1993.

Abstracts of approved Ph.D theses in the area of robotics and automation should be submitted by the advisors to the editor for publication in the Newsletter.

Proposal for an IEEE Robotics and Automation Society Magazine

DRAFT VERSION 1.8
28 March 1993

Summary

The IEEE Robotics and Automation Society proposes to transition the existing newsletter into a new magazine, the IEEE Robotics and Automation Society Magazine. The publication requirements of the society have outgrown the newsletter format. An outlet for refereed articles on: applied research, state of the shelf technologies, and educational topics is required. The Magazine will contain those technical articles along with the current newsletter features.

The proposed Magazine will be a quarterly publication starting in January 1994 with 208 pages printed in the first year. In future years it is expected that the Magazine will grow to 64 pages per issue. The Magazine will be distributed free to the 6000 members of the IEEE Robotics and Automation Society and will cost \$7.00 per year for IEEE members who belong to other societies. The Administrative Committee of the Robotics and Automation Society approved both the transition of the Newsletter into a Magazine and a three year operating budget.

Background

The IEEE Council on Robotics and Automation started publishing a quarterly newsletter in 1987. When the Council transitioned into a Society in 1990 the new Administrative Committee (Adcom) decided to increase the page budget and scope of the Newsletter with the ultimate aim to evolve into a Magazine. The last two years have witnessed a steady growth in technical content and in pages, from 16 to 32 per issue, of the Newsletter. The Adcom decided that the time is right to make the transition from a Newsletter to a Magazine.

The objective of the Magazine is to fill a void in our current publications. One can view the path from

germination of an idea to commercial application in six stages: theory development, computer simulation, physical development, prototyping, demonstration and evaluation, and state of the shelf. The premier professional society in robotics and automation needs to cover developments in all six stages. The scope is too broad for a single archival journal and newsletter. The IEEE Transactions on Robotics and Automation is the premier archival journal for presentation of initial theory development and validation, satisfying the publication requirements of the first three portions of technology evolution. The remaining three stages are ideally suited for a Magazine format.

The technical articles in the Magazine will be targeted toward prototyping, demonstration and evaluation, and commercialization of robotic and automation technology and systems. The Magazine provides an outlet for creative approaches to applying mature theories to complex real-world systems. Implementation details and lessons learned will be emphasized. Magazine articles will *close the loop* around concepts that first see light in the *Transactions*. The interested reader will be able to trace the complete cycle of technology development in the publications of one society.

Publication of the Magazine is part of the Society's overall objective to improve membership benefits and thereby increase membership. The Magazine also addresses the perception that society activities and publications are tailored strictly to the academic research community. Members must span the broad range of engineering activities involved in all aspects of robotics and automation. The Society can not flourish without the involvement of practicing engineers. The publication needs of practicing engineering community must be satisfied without furthering class divisions. The Magazine will foster cross-fertilization between the

academic and industrial portions of the membership. Practicing engineers will find topical articles that can directly impact their current and future projects. Researchers will gain a better understanding of the roadblocks between theory and practice. Both ends of the technology spectrum will gain a better appreciation for the problems and constraints of the other through this forum for freely exchanging ideas and philosophy. A second refereed publication also provides a reward system for the researcher working on projects that span the gap between theory and commercially available product.

Changing the Newsletter into a Magazine allows the society to accomplish its objectives at minimal expense and risk. The Transactions will remain the place to publish development and validation of new theories. The Magazine will capture the interest of those members of the industrial community that have gone elsewhere to find and publish important papers on applied research and state of the shelf projects.

Scope of the Proposed Magazine

The IEEE Robotics and Automation Society Magazine will bridge the gap between the IEEE Transac-

Prepared by
Michael B. Leahy, Jr.
Newsletter Editor

Robert B. Kelley
Publications Committee Chair

Rosalyn G. Snyder
Newsletter Managing Editor

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Electrical, Computer and Systems
Engineering Department
Rensselaer Polytechnic Institute
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kelley@ral.rpi.edu

tions on Robotics and Automation and commercial trade magazines. The Magazine will be built upon the existing newsletter base by adding high quality technical articles in the areas of; applied research, state of the shelf solutions and technologies, and education. Articles will be targeted toward the practicing engineer. Creative solutions to real-world problems will be emphasized. Implementation details will be highlighted. Tutorials will provide the technical and historical knowledge required to appreciate how theory evolved into actual products and systems and insight into new theoretical developments. A letters section will provide the forum for open exchange of ideas on issues facing the robotics and automation community.

Related Publications

By definition, robotics and automation is an interdisciplinary field. Sister societies, most notably the IEEE Control Systems Society, and the IEEE Computer Society, publish magazines that contain articles related to robotics and automation. Technical articles that deal primarily with a particular technology area, again like control or computers, would now have a second avenue for possible publication. The Magazine will not emphasize articles that are heavily slanted toward a subspeciality of the technologies encompassed by our society. The primary thrust is to emphasize the systems aspects and implementation issues of whole systems, not individual components. There is currently no outlet for those type of articles within the IEEE, a focal point where the practicing engineer can keep abreast of the field. The IEEE Robotics and Automation Society should be providing that service to its membership.

The commercial press publishes a variety of trade journal type of magazines with a robotics and automation emphasis. What follows is a partial list:

- Automation
- Machine Design
- Robotics World
- Industrial Automation
- Computerized Automation
- Managing Automation

- CAD Systems
- American Machinist and Automated Manufacturing
- CAD/CAM & Robotics

The trade journals do overlap with the Magazine in the area of state of the shelf articles. The important difference is that our articles will not be just sales pitches, but rather analysis of important technology developments from an unbiased viewpoint, with the quality expected of an IEEE publication with peer-review.

There are several archival publications with a robotics, not automation, focus. However all of those publications strive for the same class of papers as our *Transactions*. The *IEEE Transactions on Industrial Applications* publishes archival articles on industrial applications of both robotics and automation. However, again there is no direct overlap as industrial application follows commercialization. Therefore the Magazine will have little direct impact on the publications of sister societies and vice versa.

Sponsorship

The Magazine will be sponsored by the IEEE Robotics and Automation Society. The Society has adequate reserves so the additional expense of publishing a magazine instead of a newsletter should not be a financial burden.

Editorial Management

The management of the publication shall be vested in an Editorial Board. The Editor shall be selected by the IEEE Robotics and Automation Society Administrative Council (Adcom) and may be removed by two-thirds majority vote of the Adcom. The term of office for the Editor shall be four years, renewable by the Adcom. The Editor shall nominate Associate and Technical Editors to be approved by the Adcom. At least 50% of the editorial board shall be non-academic members. A managing editor will be hired to perform the administrative duties required for layout and publication. All actions of the Adcom concerning the Magazine, except removal of the Editor, shall be by majority vote of the Ad-

com.

Editorial Policy

Editorial selection and review shall be consistent with policies and practices of the IEEE. The papers for the initial issue will be obtained from individual solicitations, from announcements in the newsletter and from papers submitted to selected conferences. All papers will be selected for publication based on anonymous reviews obtained by the Technical Editors.

Finances

The budget for each year shall be approved by the Administrative Committee of the IEEE Robotics and Automation Society. Budget preparation is the responsibility of the Editor. The budget shall include all customary IEEE Expense and Income items.

The Adcom has approved a three year plan based on 48 pages per issue. The decision to increase to 64 pages will be reviewed after the first year of publication.

Send Us Your Suggestions

We welcome your comments and suggestions for articles, features, and format for our new magazine. We want the magazine to provide information of real interest to the whole robotics community, and we need your contributions to succeed.

Calls for Papers

Note: Fax and email submissions of papers are usually (but not always) not acceptable. Please contact the Program Chair for specific details regarding paper preparation and deadlines before submitting papers.

• **1993 IEEE/Nagoya Workshop on Learning and Adaptive Systems.** October 22-23. Nagoya, Japan. *Submissions:* Abstract by **July 1, 1993** to Fumihito Arai and Toshio Fukuda, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-01 Japan. Tel: 81-52-781-5111 ex. 6783; Fax: +81-52-781-9243. *A limited number of travel awards will be granted.*

• **1993 DND Workshop on Advanced Technologies in Knowledge based Systems and Robotics.** November 14-17. Ottawa Ontario Canada. *Submissions:* by **May 15** to Chief of Research and Development (CRA^D),

National Defence Headquarters, Constitution Bldg., 305 Rideau St., 7th Floor Ottawa Ontario K1A0K2 CA.

• **October 5-8, 1993. IPCC'93: Int'l Professional Communication Conference. Philadelphia.** *Information:* Michael B. Goodman, General Chair: Tel. (201)593-2402 Fax (201)593-8510; *Registration:* W.P. Kehoe, IPCC93 Finance, JHU/APL, 6-379, Johns Hopkins Road, Laurel MD 20723 Tel. (301)953-5000, ext 7944; Fax (301)95305937.

• **31st Allerton Conference on Communication, Control And Computing.** September 29 - October 1, 1993 Monticello, Illinois. *Submissions By July 12* to Allerton Conference, University of Illinois at Urbana-Champaign, Coordinated Science Laboratory, 1308 West Main St., Urbana, Illinois 61801. *Contact:* Paul Van

Dooren (email: vdooren@uicsl.csl.uiuc.edu; phone: (217) 333-0656) or Dilip V. Sarwate (email: sarwate@uicsl.csl.uiuc.edu; phone: (217) 333-7473)

• **ISER'93: International Symposium on Experimental Robots.** October 1993 Kyoto, Japan. *Submissions:* Oussama Khatib, SAIL, Robotics Division Department of Computer Science, Stanford University Stanford, CA 94305 U.S.A.; Prof. J. K. Salisbury, MIT Artificial Intelligence Laboratory, 545 Technology Square, Cambridge, MA: 02139 U.S.A.; or Prof. V. Hayward, McGill University, Research Center for Intelligent Machines, 3480 University, Montreal, Quebec, H3A 2A7 Canada Video submissions in addition to papers are encouraged.



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Three copies of the papers (maximum 12 double-spaced pages including figures for regular papers and maximum six double-spaced pages for short papers) should be received by May 1, 1993. Please indicate the area of the paper, and include a statement confirming that if the paper is accepted one of the authors will attend the conference to present it (please give full name, affiliation, full address and fax if available). Authors are expected to assist with the review process by reviewing a maximum of two papers.

Notification of acceptance and author kits will be mailed by June 1, 1993. The final manuscripts and an advance toward registration are due prior to July 1, 1993. Expanded papers, to be considered for publication in the International Journal of Robotics and Automation are to be sent directly to the Editor; Prof. T.C. Hsia, Department of Electrical and Computer Science, University of California, Davis, CA 95616 USA.

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Accommodation has been reserved at Christ Church and at nearby hotels.

ADDRESS

For submission of papers and to be placed on the mailing list write to:
IASTED Secretariat - RM'93
P.O. Box 354, CH-8053, Zürich, Switzerland
Fax: (01) 980-2413



•**1993 DND Workshop on Advanced Technologies in Knowledge Based Systems and Robotics.** November 14-17, 1993. Submissions: 300 wd abstract by May 15 to Chief of Research and Development (CRAD), National Defence Headquarters, Constitution Bldg., 305 Rideau St., 7th Floor, Ottawa Ontario K1A 0K@ Canada. Att: Harold Merklinger. Tel: (613)996-0761. FAX (613)996-0038.

•**MATH MOD Vienna: Int'l IMACS Symposium on Mathematical Modelling.** February 2-4, 1994, Vienna, Austria. Submissions: Abstract by May 1, 1993 to Prof. Dr. Inge Troch, Technische Universitaet Wien, Wiedner Hauptstrasse 8-10, A-1040 Wien, Austria.

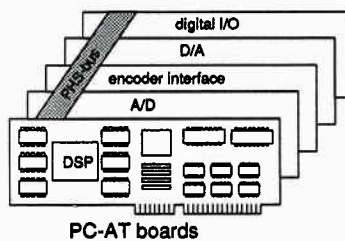
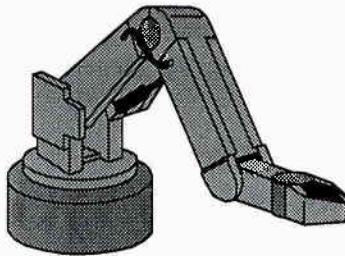
•**EP'94, The Third Annual Conference on Evolutionary Programming,** Feb. 24-25, 1994, San Diego, CA, Sponsored by the Evolutionary Programming Society, in cooperation with the IEEE Neural Networks Council. Submissions: By June 30, 1993, prospective authors should submit a 100-250 word abstract and three page extended summary of the proposed paper to the Technical Program Chairman, Dr. Lawrence J. Fogel, ORINCON Corporation, 9363 Towne Centre Dr., San Diego, CA 92121.

•**IEEE International Conference on Robotics and Automation.** May 8-13, 1994. San Diego. Submissions by October 1, 1993 to Prof. Harry E. Stephanou, NY State Center for Advanced Technology in Automation and Robotics, Rensselaer Polytechnic Institute, CII Building, Suite 8015, Troy, NY 12180 USA, Tel. 518-276-8652, FAX: 518-276-4897, e-mail: hes@ral.rpi.edu

•**Conference on Computer Integrated Manufacturing in the Process Industries (CIMPRO' 94).** April 25-26, 1994. New Brunswick, New Jersey. Sponsors: National Science Foundation and Defense Logistics Agency. Host Institution: Rutgers, the state University of New Jersey. Submissions: Send 200 word abstract to either Professor T.O. Boucher, Industrial Engineering, Rutgers University, P.O. Box 909, Piscataway, NJ 08855, or Professor Frank DiCesare, Electrical, Computer, and Systems Engineering Department, Rensselaer Polytechnic Institute, Troy, NY 12180 by Sept. 1, 1993; Notification of acceptance: Nov. 1, 1993; Final paper due: Jan. 31, 1994. Department

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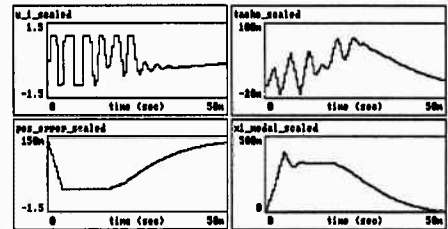
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•**WCCI: IEEE World Conference on Computational Intelligence.** June 26-July 2, 1994. Orlando FL. Sponsor: IEEE Neural Networks Council. Includes FUZZ-IEEE (Piero Bonisone, Chair); Int'l Conference on Neural Networks, (Steven K. Rogers, Chair) and International Symposium on Evolutionary Computation, Zbigniew Michalewicz, Chair). Submissions: Deadline is December 10, 1993 for all conferences. Contact: Meeting Management, 5665 Oberlin Drive, #110, San Diego, CA 92121. Tel: (619) 453-6222; FAX (619) 535-3880.

•**SYROCO'94: IFAC Symposium on Robot Control.** September 19-21, 1994, Capri, Italy. Sponsors: International Federation for Information Processing (IFIP) and the International Association for Mathematics and Computers in Simulation (IMACS). Contact: Bruno Siciliano, email: siciliano@vaxna1.na.infn.it

•**ICAR'94: 3rd Int'l Conference on Automation, Robotics and Computer Vision.** November 8-11, 1994. Singapore. Submissions: 3 copies by April 30, 1994, to N. Sundararajan, c/o ICARCV Conference Secretariat, Institution of Engineers, Singapore, 70 Bukit Tinggi Road, Singapore 1128, Republic of Singapore. Tel: (65) 469 5000; Fax: (65) 467 1108. Telex: RS 22992 IESI.

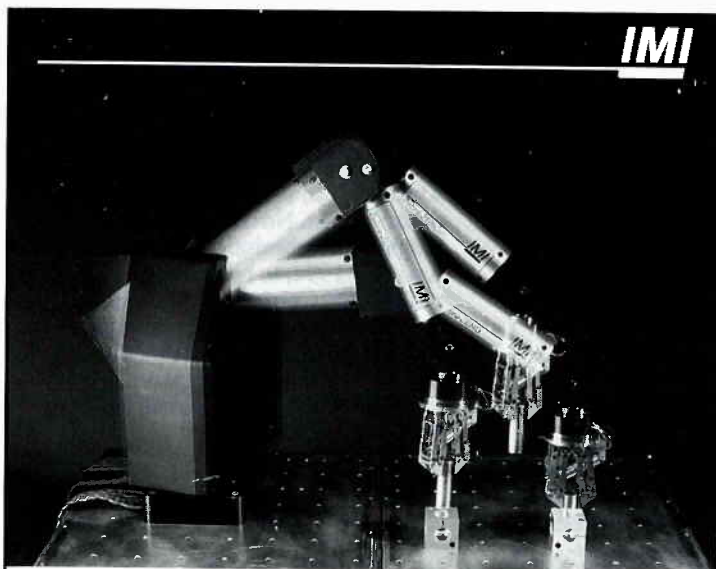
Calendar

•**May 2-9, 1993. IEEE International Conference on Robotics and Automation.** Atlanta Hilton and Towers, Atlanta GA. General Chair: W.J. Book, Georgia Institute of Technology, George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology, Atlanta GA 30332-0405 USA; Tel 404 894 3247; Fax: 404 894 9342; Email wbook@gtme.courier.gatech.edu.

•**May 9-14, 1993. IS&T's 46th Annual Conference,** Cambridge Mass. *Sponsor:* Society for Imaging Science and Technology. *Contact:* Michael R. Lee, Publications Chair, Polaroid Corp., 1265 Main St. W4-2G, Waltham MA 02154 1799. Tel 617 684 5391; Fax: 617 684 4396.

•**May 10-12, 1993. SPANN'93: IMACS Symposium on Signal Processing and Neural Networks.** Montreal, Canada. *Contact:* Prof. Z. Jacyno, Department of Physics, University of Quebec at Montreal, P.O.Box 8888, Station A, Montreal, P. Quebec, Canada, HC 3P8.

•**May 19-21, 1993 Solid Modeling '93: Second ACM/IEEE Symposium on Solid Modeling and Applications.** Montreal, Canada. *Contact:* Mary Johnson, CII 7015, RPI, Troy NY 12180. Ph(518)276-6751.



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•**June 1-4, 1993. IEA93AIE: 6th Int'l Conf. on Industrial & Engineering Applications of Artificial Intelligence & Expert Systems.** *Contact:* Paul Chung, Dept. of Chemical Engineering, Loughborough University of Technology, Loughborough, Leicestershire, England, UK, LE11 3TU, Email: p.w.h.chung@lut.ac.uk.

•**June 7-10, 1993 Transducers'93: Solid State Sensors and Actuators** Yokohama, Japan. *Sponsors:* Institute of Electrical Engineers of Japan and Japan Science Foundation. *Contact:* Secretariat TRANSDUCERS '93, c/o SANSEI International Inc., Fukide Bldg. No. 2, 1-21 Toranomon 4-chome, Minato-ku, Tokyo, 105 Japan.

•**June 13-16 1993. CBMS 93: IEEE Computer Based Medical Systems Symposium.** Ann Arbor Michigan. *Sponsors:* IEEE and Engineering in Medicine and Biology Society. *Contact:* Timothy J. Kriewall, Ph.D., Sarns, 3M Health Care, 6200 Jackson Road, Ann Arbor MI 48106; 313 741 6276.

•**June 15-17, 1993 IEEE Conference on Computer Vision & Pattern Recognition** New York City. *Contact:* Yiannis Aloimonos, Computer Vision Laboratory, Center for Automation Research, A. V. Williams Building, 115 Paint Branch Drive, University of Maryland, College Park, MD 20742-3411.

•**June 16-18Nov, 1993. International Unmanned Ground Robotics Competition** Rochester Michigan. *Sponsor:* Association for Unmanned Vehicle Systems (AUVS). \$10,000 prize to the university team for the best Autonomous Unmanned Ground Vehicle. *Contact:* Ka C. Cheok or Candy McClellan, Oakland University, School of Engineering & Computer Science, 248 Dodge Hall, Rochester MI 47398-4401. Tel. (313) 370-2231, Fax: (313)370-4261.

•**June 17-19, 1993. Int'l Forum on Dimensional Tolerancing and Metrology.** Dearborn Michigan. *Co-Sponsors:* ASME and NSF. *Contact:* Lisa Strachan, ASME, 1828 L Street NW, Suite 906, Washington DC 20036-5104. Tel.(202)785-3756. FAX 202-429-9417. email: 7153.151@compuserve.com.

•**June 21-25, 1993 PetriNets'93: 14th Int'l Conf. on Application and Theory of Petri Nets.** Chicago. *Contact:* Marco Ajmone -Marsan, Dipartimento di Elettronica, Politecnico di Torino, Corso Duca degli Abruzzi 24, I-10129 Torino Italy. Tel.: 39 11 5644032. Fax 39 11 5644099 email: ajmone@itopoli.bitnet.

•**June 28-30, 1993. FAIM93: Flexible Automation and Integrated Manufacturing.** University of Limerick, Ireland. *Contact:* Marie Sheehy, FAIM 93 Secretary. Tel 353-61-333644; FAX: 353-61-338175; email sheehym@ul.ie.

•**July 14-16 1993 Intelligent Vehicles '93.** Tokyo. *Sponsor:* IEEE and SAE. *Contact:* Ichiro Masaki, Computer Science Dept., General Motors' Research Laboratories, 30500, Mound Road, Warren MI 48090-9055 USA. Tel: 313-986-1466; Fax 313 986 9356; email masaki@gmr.com.

• **July 14-16 Robots for Competitive Industries** Brisbane, Queensland, Australia. *Sponsor:* Australian Robot Association and the International Federation of Robotics. *Deadline was Jan 15, but contact* Hartmut Kaebemick, School of Mechanical and Manufacturing Engineering, University of New South Wales, PO Box 1, Kensington NSW 2033, Australia, fax +61 2 663 1222. *Registration:* Australian Robot Association, INC, GPO Box 1527, Sydney NSW 2001 Australia, Tel.: 61 959 3239. Fax 61 2 959 4632; email: michael@extro.ucc.su.oz.au

• **July 17-22. Fifth International Conference on Genetic Algorithms.** University of Illinois at Urbana-Champaign, *Sponsor:* The International Society for Genetic Algorithms, *Contact:* Prof. Stephanie Forrest, Dept. of Computer Science, University of New Mexico, Albuquerque, N.M. 87131-1386, phone: (505) 277-3112, fax: (505) 277-0813, email: icga93@unmvax.cs.unm.edu

• **July 26-30 IROS 93: Int'l Conf. on Intelligent Robots and Systems.** Yokohama Japan *Contact:* Masatsugu Kidode, Kansai Research Lab., Toshiba Corp., 8-6-26 Motoyama-Minami-cho, Higashinada-ku, Kobe; 658 Japan, tel: 81 78 435 3502; fax 81 78 435 3678 or Tomomasa Sato, Research Center for Advanced Science and Technology, University of Tokyo, 4-6-1 Komaba, Meguro-ku, Tokyo, 153 Japan, Tel 81 3 3481 4479 Fax: 81 3 3481 4584.

• **July 30-31 1993 IEEE/Nagoya Workshop on Multiple/Distributed Robot Systems: Architecture and Control for Coordination and Cooperation.** Nagoya Japan. *Contact:* Prof. Kazuhiro Kosuge, WWW on M.D.R.S., Dept. of Mechano-Informatics and Systems, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-01 Japan. Tel: 81-52-781-5111 ex. 6783; Fax: +81-52-781-9243.

• **August 2-4, 1993 ICAM'93: Int'l Conf. on Advanced Mechatronics Yokahama, Japan.** *Contact:* Jun'ichi Takeno, School of Science and Technology, Meiji University, 1-1-1 Higashi-ita, Tama-ku, Kawasaki-shi, Kanagawa-ken 214, Japan, Tel 044 934 9454; 044 934 7912 (Japan) International Tel/Fax 81 44 934 2880.

• **August 25-27 IEEE Int'l Symposium on Intelligent Control** Chicago. *Sponsor:* IEEE Control Systems Society. *Contact:* Kevin M. Passino, ISIC'93, Dept. Electrical Engineering, Ohio State University, 2015 Neil Ave., Columbus Ohio 43210-1272. Tel. (614)292-5716. email: passino@eagle.eng.ohio-state.edu. *Workshop & Tutorial Proposals:* Panos J. Antsaklis. Tel. (219)239-5792; Fax (219) 239-8007; email flxfsn@irishmvs.cc.nd.edu.

• **August 29-September 3, 1993. IJCAI'93: Int'l Joint Conf. on Artificial Intelligence.** Chambery Savoie France. *Contact:* Ms. Catherine Vidonne, Danzas/IJCAI 93. 14 rue des Bains, BP431 - 43104 Aix-Les-Bains Cedex France. Tel 33 79 5 66 22; fax 33 79 61 36 92; email: vidonne@imag.fr.

• **August 30-Sept. 3 1993. Software Engineering Standards Symposium.** '93 Brighton, England. *Sponsor:* IEEE Computer Society. *Theme:* Internationalization of Industrially Useful Software Engineering Standards (SES) *Contact:* Sal Mamone, Nynex Corp., 500 Westchester Ave, White Plains NY USA. Tel +1 914 644 2237 Fax +1 914 644 2191

• **September 7-9, 1993 IEEE Workshop on Neural Networks for Signal Processing.** Baltimore MD. *Contact:* Gary Kuhn, NNSP'93, Siemens Corporate Research, 755 College Road East. Princeton, NJ 08540.

• **September 13-16 1993. ICANN-93: International Conference on Artificial Neural Networks (ICANN'93).** Amster-

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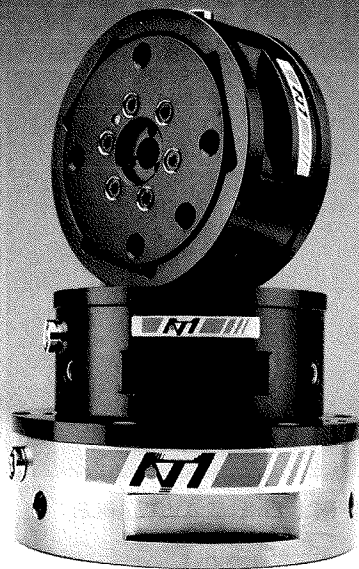
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dam, Topics include: Computational principles from neurobiology, Physical and Mathematical theories, Cognitive connectionism, Robotics, Applications. *Contact:* ICANN'93 Secretariat, Novep, Paulus Potterstraat 44, 1071 DB Amsterdam, The Netherlands. Tel. 31-20-6714814, Fax 31-20-6628136, email icann@mbfys.kun.nl.

• **September 13-16, 1993. 2nd IEEE Conference on Control Applications.** Vancouver, BC Canada. *Sponsor:* IEEE Control Systems Society. *Contact:* Dr. C. de Silva, Dept. of Mechanical Engineering, University of British Columbia, Vancouver, BC Canada, V6T 1Z4. Fax: (604)822 2403.

• **September 18-22, 1993, VRAIS'93: Virtual Reality Annual Symposium.** Seattle, Washington. *Sponsor:* IEEE Neural



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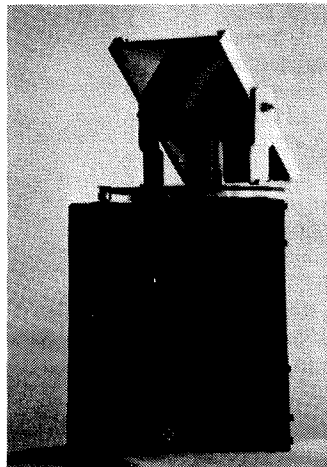
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• **September 20-23, 1993. BMVC93; 4th British Machine Vision Conference.** Guildford, England, UK. *Contact* John Illingworth, Dept, Electronic and Electrical Engineering, University of Surrey, Guildford. GU25XH UK. Tel: 0483 509835. Fax: -493 34130. email: J.Illingworth@ee.surrey.ac.uk.

• **September 29 - October 1, 1993. 31st Allerton Conference On Communication, Control And Computing.** See Calls for Papers.

• **October 5-8, 1993. IPCC'93: Int'l Professional Communication Conference. Philadelphia.** *Information:* Michael B. Goodman, General Chair: Tel. (201)593-2402 Fax (201)593-8510; *Registration:* W.P. Kehoe, IPCC93 Finance, JHU/APL, 6-379, Johns Hopkins Road, Laurel MD 20723 Tel. (301)953-5000, ext

7944; Fax (301)95305937.

• **October 1993, ISER'93: Int'l Symposium on Experimental Robots.** (See call for papers)

• **November 1-2, 1993, '93 ICAR: Int'l Conference on Advanced Robotics.** Tokyo. *Contact:* Robotics Society of Japan, Bunkyo Shogaku Bldg., 6F 1-15-4 Hongo, Bunkyo-ku Tokyo 113 Japan. *Contact:* Ms. Kazuko Higu-chi, Fax +81 3 3812 4628.

• **November 4-6, 1993 ISIR: Int'l Symposium on Industrial Robots.** Tokyo. *Contact:* Secretariat of 24th ISIR, Japan Industrial Robot Association, Kikai Shinko Kaikan Bldg., 3-5-8, Shiba-Koen, Minato-ku, Tokyo 105, Japan. Tel.: +81 3 3434 2919; Fax: +81 3 3578 1404.

• **November 14-17, 1993. 1993 DND Workshop on Advanced Technologies in Knowledge Based Systems and Robotics.** (See call for papers).

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New Orleans, Univ. of Maryland, College Park, MD 20742, USA. Contact Johanna Weinstein by e-mail at: camp93@umiacs.emd.edu.

•February 2-4, 1994 MATH MOD Vienna: Int'l IMACS Symposium on Mathematical Modelling. (See call for papers).

•May 8-13, 1994, IEEE International Conference on Robotics and Automation. San Diego. (See call for papers).

•September 19-21, 1994, SYROCO'94 (See call for papers).

•May 22-May 27, 1995, IEEE Int'l Conference on Robotics and Automation. Nagoya, Japan. Contact:



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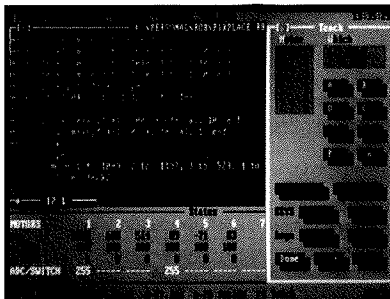
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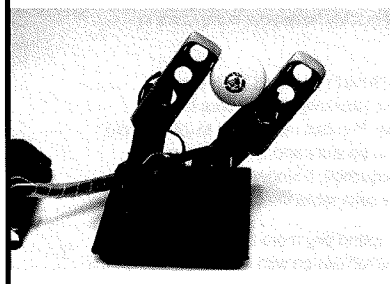
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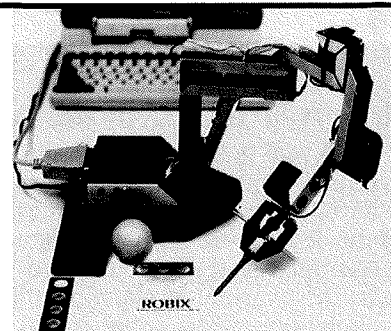
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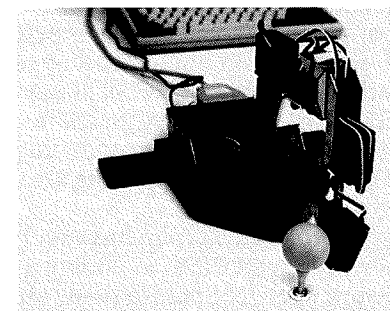
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