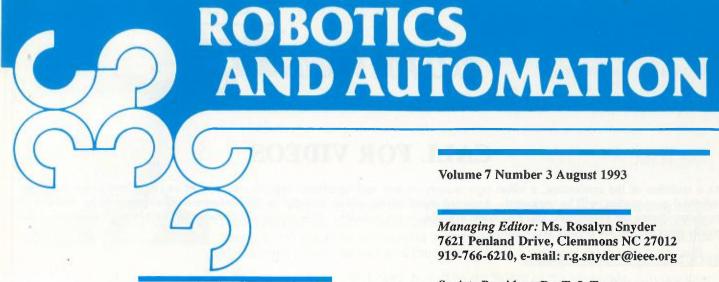
Newsletter of the IEEE Robotics & Automation Society



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CALL FOR VIDEOS

As a tradition of the conference, a video tape session on new and significant experimental results and demonstrations including industrial case studies, will be organized. Accepted contributions will be included in the conference video proceedings, which will be shown during the conference, and also made available to the attendees. This program is intended to enhance and complement the results presented in the regular proceedings.

REQUIREMENTS FOR VIDEOS:

• A good video should be dynamic and contain information that cannot be easily conveyed in a paper.

• Length should not exceed 2 to 3 minutes. Showing flow charts, block diagrams, circuit boards, computers, or motors is discouraged. Operators are fine if they are central elements to the concept being illustrated (e.g. in teleoperated systems).

• Narration is important. Ideas should be expressed without jargon. Music and background noise generally interfere with the presentation. Music should be avoided unless it is generated professionally.

• The purpose of the video proceedings is to disseminate technical information, not commercial promotion. For example, the obvious display of company logos must be avoided.

SUBMISSION:

Submissions consist of a 2 to 3 minute video segment (preferred formats are 3/4", Betacam or super VHS) and an information sheet including: the title of the presentation, the names, affiliations, and addresses of the authors (please identify the corresponding author), and a 200 word abstract. They should be submitted by October 1, 1993. A \$1,000 prize will be awarded for the best video. Submit to the Program Chair:

Harry E. Stephanou

New York State Center for Advanced Technology in Automation and Robotics
Rensselaer Polytechnic Institute
Troy, New York 12180-3590
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President's Message



Tzyh-Jong Tarn Washington University

July 14, 1993

I just returned from the IEEE Technical Activities Board (TAB) Meeting in San Juan. The TAB has approved the publication of the Robotics and Automation Society Magazine. Congratulations are due to Robert Kelley, Michael B. Leahy, Jr. and Rosalyn Snyder. They spent a lot of time in preparing a proposal for the Robotics and

Automation Society Magazine. Michael B. Leahy, Jr. will be the Editor of the Magazine. Anyone interested in getting involved please contact Michael B. Leahy, Jr. His address appears on the cover of this newsletter.

At the TAB Meeting, one of the new IEEE initiatives is to increase transnational participation. New IEEE centers are being established in Europe and in Asia. Currently 25% of the Robotics and Automation Society's 5631 members were located outside of the U.S. It is predicted that this will go up to 40% by the year 2000. I have received the following suggestions that are reflective of the international character of our Society.

1.To increase the representation of the AdCom members and officers from underrepresented regions; and

2. To encourage the Chapter Chairpersons in attending the AdCom meetings.

Please let me know if you have any good ideas.

This year the Annual Robotics and Automation Conference was held in Atlanta in May. From my perspective it was a resounding success. It is quite appropriate to recognize both the strong technical and financial success of this Conference, in spite of the recession. The papers were of high quality, the sessions were crowded, the receptions, banquets, and other social events were delightful. We thank Wayne Book, John Luh, and many others involved for doing such a superb job. The Society derives its income from two major sources: membership dues and surplus from the conferences sponsored by the Society. In the economic times of today, it is difficult to expect to have regular surplus. At the last AdCom Meeting held in Atlanta, the Administrative Committee voted to activate the Conference Board of the Robotics and Automation Society. This board was charged with the long range planning of the future conferences and to provide much needed continuity from year to year. Norman Caplan from the National Science Foundation has kindly agreed to serve as the first chairman of the board.

Each year the Robotics and Automation Society elects six Administrative Committee members to serve a three year term. Norman Caplan is the Chairman of the Nominations Committee for the 1994 election. Those of you who are interested in serving please contact Norman before September, 1993. Of course, a member may submit a nominating petition carrying signatures of a minimum of 25 members, excluding student members, of the Robotics and Automation Society to automatically place his/her name on the election slate.

From the Editor's Desk



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

Greetings and welcome to another issue of your Robotics and Automation Society Newsletter. I hope this message finds you in good health and good spirits.

The IEEE Technical Activities Board (TAB) has formally approved our publication request to expand the Newsletter to an IEEE Magazine. With that accomplished we are now formally soliciting technical articles for the Magazine. To help you determine if your research, development, and/or prototyping activities are suitable for Magazine publication, this issue includes an article on information for prospective Magazine authors. Please take a moment to review that information and consider contributing to this new enterprise.

If you want to publish in the Magazine, I encourage you to take advantage of our extended abstract preliminary review process. As with any new publication ours will go through a maturing process. Without any prior issues to serve as a guide the scope is always a little fuzzy. In anticipation of some confusion about what is and isn't an acceptable Magazine paper, we have instituted the extended abstract review process to provide quick feedback to prospective authors. This timely review saves both the author and peer reviewers time and effort.

I don't know if it is related to all the talk about the Magazine, but we have one of our biggest and most interesting Newsletter issues to date. Let's keep on building momentum as we rush toward 1994. This issue highlights several columns that I would like to see receive increasing utilization.

Debra Hoitomt is leading a very active Technical Committee on Computer-Aided Production Management and has contributed two articles. One topic overviews some of the compelling issues in the dynamic field of agile manufacturing, while the second contribution reports on her TC's recent activities and plans for the future. We need more TCs to follow that example and use the Newsletter/Magazine as a communication conduit to the members and beyond.

From conversations with industrial systems houses and technology suppliers I know that more than just "academics" read the Newsletter and in light of the global push toward "relevant" research we need to use all the tools at our disposal to build a solid, mutually beneficial relationship between all the players in the wide field of robotics and automation.

Pat Eicker is chairperson of a committee that is chartered to assess the changing relationship between industry, government, and academia. Like Debra, he is taking advantage of the Newsletter to accomplish that goal. Information about the committee's first meeting at ICRA 93 and its goals and objectives is presented. The topics of "curiosity-driven" versus "relevant" research and interagency relationships always brings up some heated debate. I think that is healthy, and we need more of it. If the engineering community cannot come to grips with these technology driven issues and develop a recommended policy, how can we expect the politicians to do any better? Let's use the Newsletter to foster the debate. If you feel strongly about this topic, or any other affecting our society, send in a letter to the editor. Write a professional, nonpersonal, letter, stating your views. Dare to share.

The rest of the issue is full of the normal Newsletter items: conference calls and calenders, PhD abstracts, society news, and laboratory reports. I hope you find those sections interesting and informative. I look forward to your input for our next issue.

IEEE ROBOTICS AND AUTOMATION SOCIETY MAGAZINE

INFORMATION FOR AUTHORS

The IEEE Robotics and Automation Society Magazine publishes high quality technical articles in the areas of: prototyping, demonstration and evaluation, and on site implementation of robotics and automation systems. Submissions should emphasize creative approaches, implementation details, and lessons learned from applying mature theories to complex real world problems. The RAS Magazine is published quarterly. Four types of technical contributions are regularly considered:

1. Papers - Presentations of significant prototyping, demonstration and evaluation, or implementations of robotics and automation systems

2. Tutorials - Clear explanations of the technical and historical background required to appreciate how theory evolves into applications, and insights into new theoretical developments

3. Letters - Significant remarks of interest to robotics and automation systems engineers, perspectives on current technology trends, and comments on regularly pub-

lished papers

4. State of the Shelf - Objective evaluations of what's new in the market

Papers and tutorials go through the same peer review process. Letters and State of the Shelf contributions go through a shorter review process to facilitate rapid pub-

A. Submission process

lication.

Prospective authors are encouraged to send an extended abstract of proposed papers and tutorials to the editor. The extended abstract should contain the following sections: background, problem statement, objective, contribution, and outline. Length should not exceed three single-spaced pages. Email or fax is preferred to facilitate quick review. After editorial board review the author will be encouraged to submit the full article for peer review or advised that his/her proposal is not consistent with the scope of the RAS

Five copies of the complete manuscript with a cover letter stating the type of contribution (paper, tutorial, letter, state of the shelf) and the name and address of the corresponding author should be sent to the

Editor:

Major Michael B. Leahy Jr. IEEE Robotics and Automation Society Magazine SA-ALC/TIEST 450 Quentin Roosevelt Rd. Kelly AFB, TX 78241-6416 email: m.leahy@ieee.org fax: 210-925-4916

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Submitted manuscripts must be typewritten in English. Specific guidelines are as

follows.

1. The contribution of the paper should be presented in a manner that makes it accessible to the interested robotics and automation engineering professional. Descriptions and intuitive insight and interpretation are preferred to formal mathematical development (lemmas, theorems, and proofs). Detailed mathematical derivations (over 20 equations) are not appropriate. Theoretical developments should be sent to the Transactions.

2. Full length submissions must be double spaced 12pt type with adequate margins and a maximum length of 32 pages including references, tables, and figures. Papers longer than 32 pages will not be reviewed without prior editor approval.

3. References must be typed double-spaced in a separate section at the end of the paper, with items referred to by numerals in square brackets. References must be completed in IEEE style. The total number of references should not exceed 12.

4. The cover page should contain the title; name, affiliation, and complete mailing address of all authors; and a single paragraph abstract which briefly and clearly describes the contribution of the paper.

5. If accepted for publication, the text of the paper must be available electronically as a standard computer-readable ASCII text file. Instructions for electronic submission will be provided when the paper is accepted for publication. Manuscripts exceeding the specified page limits, or clearly outside the scope of the Magazine will be returned without a

review.

D. Style for Illustrations

1. It is in the author's interest to submit profession quality illustrations. Drafting or art service cannot be provided by the IEEE.

2. Original drawings should be in black ink on white background. Maximum size is restricted to 21.6 by 27.9 cm. Glossy prints of illustrations are also acceptable.

3. All lettering should be large enough to permit legible reduction of the figure to column width, sometimes as small as one quarter of the original size. Typed lettering is usually not acceptable on figures.

4. Lightly pencil each figure number on the back of each original illustration. Captions should not appear on figures.

5. Provide a separate sheet listing all figure captions, in proper style for the typesetter, e.g., "Fig. 5. The error variance for the

optimal filter .:

6. Contributors' photographs should measure between 1.6 cm and 9.5 cm across the widest part of the head. The overall size of the photographic paper used can be anything from passport size to 21.6 by 27.9 cm.

E. Page Charges

After a manuscript has been accepted for publication, the author's company or institution will be approached with a request to pay a charge of \$110 per page to cover part of the cost of publication. Payment of page charges for this Magazine, like transactions and other professional societies, is not a necessary prerequisite for publication. The author will receive 100 free reprints (without covers) only if the page charge is honored. Detailed instructions will accompany the proofs.

F. Special Issues

The magazine will run up to two special issues each calendar year. A special issue consists of an introduction from the guest editor, and three-five technical articles. A tutorial article is highly encouraged. Individuals wishing to sponsor special issues should submit a concise package which includes the following: motivation, listing of specific topics, potential authors, proposed call for papers, and proposed editors. Special issues must also be coordinated through the appropriate society technical committee chairperson. The editorial board will review the package and make recommendations on scope and content. If the issue is tentatively approved, full papers will be solicited and then put through the normal peer review pro-

G. Society News Submissions

The RAS Magazine also actively solicits the types of information found in the old society Newsletter. Information about conferences, workshops, new publications, research and industry, and other professional activities of the IEEE Robotics and Automation Society are invited. Newsworthy information should be sent directly to the Managing Editor with a courtesy copy to the editor (electronic format is preferred.)

Ms. Rosalyn Snyder 7621 Penland Drive Clemmons NC 27012 (919)766-6210 (call to send fax) email: r.g.snyder@ieee.org

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IEEE Robotics and Automation Society News

TECHNICAL COMMITTEE REPORTS

C. S. George Lee Purdue University Vice President for Technical Affairs

•Industry, University, & Government Cooperative

Chair: Patrick J. Eicker Sandia National Laboratories

Background

In one form or another, intelligent machines, intelligent processes or intelligent robotics are on every list of technologies which are deemed to be important in the 21st century. Intelligent machines are important to future manufacturing, are needed for application in space, are necessary to clean up the environment, and may play a role in future defense systems.

Charter

Given this background, the Industry, University, Government Cooperative Committee (IUGCC) will:

 -Assess the changing relationships within and among the three sectors - industry, government, university. Assess the emerging needs for research, development, and application in robotics and automation.

 Develop a "Blueprint for the Future Research, Development, and Application of Intelligent Machines and Processes" which could be recommended to decision makers in governments, industry, academia, and professional societies.

The committee sponsored a panel discussion at ICRA93-Atlanta.In id-May, plans for the IUGCC were presented to the board of directors of the Robotic Industries Association (RIA) and the board expressed strong support for thegoals.Brian Carlisle agreed to be the official RIA representative on the IUGCC. In addition, Kim Spitznagel, member of the RIA board and Director of Technology at Motorola will participate on the IUGCC.

If you would like to participate in the activities of this committee, please contact

Patrick J. Eicker Sandia National Laboratories PO Box 58100, 1600 Albuquerque, NM 87185 e-mail: eicker@sandia.gov

 Sensor Integration and Fusion

> Chair: Ren C. Luo North Carolina State University

A Call for Participation for forming a working group of research on Multisensor Fusion and Integration (MFI) through e-mail and regular mail was been initiated in May 1992. The responses have been very good.

A mini working group meeting of MFI was held on July 9 1992, during the IROS'92 Conference (1992 IEEE/RSJ International Conference on Intelligent Robots and Systems). Possible activities discussed include sponsoring a focused conference in this particular area.

A special session for Sensor Fusion and Integration was organized by Professor M. Ishikawa at the University of Tokyo and Profes-

ICRA94 Developing Countries Travel 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
Computer Science Department
Univ. of Southern California
Los Angeles CA 90089-0782 USA

Tel: 213 740 7285 Fax: 213 740 7285

email: bekey@pollux.usc.edu

Industry University, & Government
Cooperative Committee Membership
(as of May 6, 1993)
Patrick Eicker - Sandia National Laboratories
- Chair
Norman Caplan - National Science Founda-

P. Luh - University of Connecticut
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Brian Carlisle - Adept Technology
Lothar Rossol - Trellis Software and Controls

Steve Holland - General Motors Enk Mettala - ARPA Jim Albus - National Institute of Standards

and Technology Debra Hoitomt - University of Connecticut Thurston Brooks - Hughes STX

Thomas A. Owens - Cannondale Corporation T. J. Tarn - ex officio

International Micro Robot Maze Contest Rules

- 1 The robot must pass through several control points in the maze. The location of the control points for the contest will be unveiled at the contest site.
- 2 A robot will leave the starting point to climb up a mountain whose maximum slope is 15 degrees, passing through the selected spots in the maze to reach the goal. The layout as in fig. 1 will be prepared at the contest site. The materials of this layout will be an aluminum alloy to avoid electrostatic charge and its surface will be finished with fine aventurine so that the machine should not slip.
- 3 The maximum dimensions of the body are 1.0 cm x 1.0 cm x 1.0 cm.
- 4 Energy or control signal can be provided from cables or flexible tubes outside. However, the robot should not be pushed directly by air pressure, a stick, and so on. These cables or tubes will not be counted as part of the robot.
- 5 The judgement will depend on a) idea, b) possibility of miniaturization, c) achievement of goal, d) running performance, e) humor, and so on.
- 6 The theme is quite difficult. The work need not be decorated. It is desirable if the robot can meet the requirements with a simple structure.

sor Ren C. Luo for the International Symposium on Robotics, Mechatronics and Manufacturing Systems'92 (Kobe Japan, September 16-20,1992). Nine papers were presented in this special session.

Prof. Ishikawa and Prof. Luo jointly gave a 4 hour seminar for about 75 participants at Kawasaki City of Japan during the annual meeting of Tokyo Chapter of IEEE Robotics and Automation on December 22 1992.

Professor Luo and Professor Ishikawa organized special sessions at the IEEE Robotics and Automation International Conference in Atlanta, with 12 papers.

The International Conference on Multisensor Fusion and Integration for Intelligent Systems will be held in Las Vegas, Nevada on October 9-12 1994. This Conference will be sponsored jointly by the IEEE Industrial Electronics Society, IEEE Robotics and Automation Society, Robotics Society of Japan and The Society of Instrumentation and Control Engineers. (see announcement).

Micro Robotics & Cellular Robots

Co-Chairs: Paolo Dario, Scuola Superiore S. Anna and Toshio Fukuda, Nagoya University

The committee will be a cosponsor of the International Micro Robot Maze Contest (October 15,1993, Nagoya, Japan) in Cooperation with Nagoya University and others. The contest will be held in parallel with the Fourth International Symposium on Micro Machine and Human Science (October 13-15, 1993). The goal of this contest is to promote the development of autonomous micro robots.

As a first step toward autonomous intelligent micro robots, teleoperated micro robots, whose dimensions are less than 1.0 cm x 1.0 cm x 1.0 cm, will compete in a time trial contest. Each robot will be required to pass through several selected points in a maze in going from start to finish. Participants from academia, companies, private teams, individuals, etc. are all welcomed. The participants will be classified into the amateur and the professional, and the contest will be competed in each class.

All correspondences and applications should be addressed to:

Prof. Toshio Fukuda

General Chairman
3rd International Symposium on
Micro Machine and Human Science
c/o Inter Group Corp.
Sakae East Bldg. 4-2-7
Sakae, Naka-ku, Nagoya 460
Japan
Phone: +81-52-263-6261
Facsimile +8 1-52-263-6298

Standards

Chair: Leonard S. Haynes
Intelligent Automation, Inc.
Chairman Leonard Haynes represented the Robotics and Automation Society at a meeting of the IEEE Metric Policy Committee. He submitted to the RA AdCom in Atlanta the latest draft of a proposed IEEE policy with regard to metrification which had been adopted at that meeting.

The AdCom, voted unanimously to support the current draft policy on metrication *provided* that the policy be modified to always allow experimental procedure and experimental results to be reported in the system in which those experiments were performed and the results measured.

A letter from Dr. Haynes to Mr. Bruce Barfrow, Chair of the IEEE Metric Policy Committee explains the Society's opposition to the draft policy in its current form:

"Metrification is a worthy goal

Proposed IEEE Metric Policy (as amended)

The IEEE will:

- 1. Actively support the use of the \$I metric system in electrical and electronics engineering.
- Use SI units exclusively to express measured and calculated values of quantity in all IEEE publications including standards.
- 3. Use the current Issue of IEEE Standard 268.
- 4. Promote the use of SI at all levels of education.
- *It is recognized that certain exceptions to this policy will be necessary (e.g. where a conflicting world industry practice exists). These exceptions must be evaluated and approved by the appropriate Institute board on an individual basis, and for a specific period of time, and reported to the Board of Directors.

CALL FOR NOMINATIONS: RA ADCOM

The Robotics and Automation Society currently has an 18-member Administrative Committee (AdCom) rotating on three-year terms. Beginning next year, we need to fill six vacant AdCom positions by election in October. Mr. Norman Caplan, Chairman of the Nominations Committee, is working closely with Professor T. J. Tarn, President of the Society, to come up with a slate of candidates for the six vacant AdCom positions. I strongly urge anyone who is interested in the affairs of the Society to volunteer himself/herself.

There are two channels to be nominated for election to the AdCom. As stated in the Society Bylaws, anyone can be nominated with petitions signed by twenty-five (25) or more members of the R&A Society. These petitions must be received by Mr. Caplan (Address: National Science Foundation, BES, Room 1131, 1800 G Street, N.W., Washington, D.C. 20550) or me (Address: Dept. of Electrical Engineering, The Ohio State University,

Columbus, OH 43210) by September 1.

It is also possible to be nominated through the Nominations Committee. Just send Mr. Caplan your updated short bio, resume and your areas of expertise. Although the Nominations Committee may not be able to nominate everyone who volunteers to the AdCom, the Society has many appointed positions that may be able to use your talent and service.

David E. Orin The Ohio State University Robotics & Automation Society Secretary

and it should be pursued aggressively whenever feasible, however technical accuracy and meticulous reporting of experimental procedures and results is paramount. Any author should have the right to report measurement in the system in which those measurements were made, exactly as they were reported on his or her experiment logs. To insist authors alter experimental data for any reason is inconsistent with the Society's adherence to the highest standards of scientific accuracy. The draft metrification policy, if adopted by the IEEE in its current form would compromise the scientific integrity of all IEEE publications."

At the next meeting of the IEEE Metric Policy Committee, the letter was discussed at length. Those in favor of retaining the word "exclusive" argued that the United States has delayed metric conversion for years and needs the incentive to

change. No action was taken at that meeting.

With respect to the R&A Society, Chairman Haynes said the primary impact if this policy is ultimately approved by the IEEE Board of Directors is that all publications will be required to use the metric system exclusively unless a specific exception is granted.

In some fields there are well established industry practices where changes would be difficult to enforce. An example is in aviation where altitudes are always given in feet, or in power engineering where wire sizes use the AWG standard which is inch-based. To the best of my knowledge, however, this should not be the case in the R&A Society and authors should have little difficulty converting their data into SI metric system units.

In response to several requests for a representative to address the American National Standards Institute (ANSI) Computer Integrated Manufacturing Standards Board (CIMSB), Dr. Haynes will attend their next Washington meeting as a representative of the R&AS. No specific topic for the meeting was stated other than general information on current, proposed, or possible future standards relevant to robotics.

•Computer Aided Production Management

Chair: D.J. Hoitomt University of Connecticut

Production management is concerned with all functions and methods which facilitate the transfer of raw materials into salable goods. These include but are not limited to: inventory management, material handling, routing, scheduling, and shop floor control systems.

A wide variety of production environments may be considered in automating these activities, from traditional job shops to flexible manu-

facturing systems.

The Computer-Aided Production Management (CAPM) Technical Committee has an orientation on practical (implementable) methodologies which can improve productivity.

Special sessions at Robotics and Automation conferences spotlight innovative techniques currently used in factories. For example, a session on practical scheduling was organized for the 1991 Robotics and Automation Conference in Sacramento, California.

In addition, computer-aided production management is complicated by the large range of dynamic behaviors associated with manufacturing systems, from arrival of new parts to machine breakdown. This year, in Atlanta, a special session was organized which focuses on managing change in manufacturing systems.

CAPM interacts extensively with many related manufacturing functions, such as assembly or process planning, which correspond to other technical committees within the Robotics and Automation Society. Therefore, joint membership(s) in one or more technical committees is natural and encouraged. The current goal of the CAPM Technical Committee is to organize a workshop at the 1994 International Robotics and Automation Conference in San Diego exploring the implications of the paradigm shift in manufacturing.

The direction of this shift increases the reliance of manufacturing on robotics and automation. The members of the Society are encouraged to contribute ideas, energy and vision toward developing relevant and timely presentations at this workshop. Initial topics for discus-

sion include:

- Modular (or object oriented)
 approaches to product, software
 and/or machine (or robotic)
 design;
- System integration from customer (marketing) to product design to manufacturing to delivery;
- Standardization across heterogeneous networks and databases.

If you wish to become active in the technical committee or play a role in the workshop, please contact

Prof. D. J. Hoitomt University of Connecticut Electrical and Systems Engineering Box U-157 Storrs, CT 06268

Tel: (203) 486-6306 Fax: (203) 486-1273 hoitomt@brc.uconn.edu

R&A PRESIDENTS at ICRA93: T.J. Tarn, John Jarvis, Antal Bejczy, George Sarldis, and Norman Caplan



Judy Book, logistics coordinator for ICRA and Wayne Book, ICRA General Chair



John Luh, ICRA93 Program Chair



The 10th International Conference on Robotics and Automation returned to Atlanta with a highly successful repeat performance. Over 650 registrants attended 112 sessions presenting 448 papers on Monday, Tuesday and Wednesday, May 3-5. In addition 40 student volunteers attended in return for their assistance at the conference. Ten workshops were presented to 200 registrants on the days immediately before and after the conference. Three industrial tours to Ford, G.M. and Lockheed Georgia were also held with enthusiastic participation. Shuttle buses to a Tuesday tour of Georgia Tech were overwhelmed as registrants visited Tech's Manufacturing Research Center, the Materials Handling Research Center and the Graphics Visualization and Usability Laboratory.

Since the 1992 Conference was in Nice, France, outside the U.S. for the first time, we looked back to the record-setting 1991 Conference in Sacramento, CA, for comparisons. Over 690 registered for that conference. The 5.6% decrease in registration was much smaller than that experienced by many other conferences in this time of economic difficulty. The American Control Conference, for example, was down in registration for 1993 by 17% from 1992.

Two plenary addresses gave perspectives on the past and future of robotics and automation. Dr. Daniel Whitney of The Charles Stark Draper Laboratory related his own transition from research in robot controls to research in product design to changes in perceived needs and opportunities for robotics research. Dr. William Hamel of the Oak Ridge National Laboratory also reached into the robotic history book to give us a glimpse into the future.

His perspective came from the remote handling of radioactive materials and most currently nuclear wastes.

New value was added to the conference with a floppy disk provided to all registrants containing the titles and 94% of the papers presented at the conference. This addition gives the Society a first step toward an electronic proceedings, and allows us to evaluate the utility of these nontraditional formats. All registrants are reminded that your feedback on the enclosed survey form is critical to a valid evaluation of the floppy disk, and the possibility of a CD ROM production.

The Conference Video was well received with approximately 300 copies being sold at the conference. Thirty-two segments included in the tape were grouped into seven areas ranging from design and control to applications.

For 1994 the Robotics and Automation Conference moves West to San Diego. Chairs for that conference, William Gruver and Harry Stephanou, promise a wonderful beginning to the second decade of these conferences.

Awards Luncheon

Awards abounded at the Luncheon Banquet. For the first time, a Best Conference Paper Award was given with a \$1000 award. Winners of the Anton Philips Award for the Best Student Paper and the Video Award were also announced. David E. Orin and George C.S. Lee two of the seven Robotics and Automation Society IEEE Fellows, received their awards, and past presidents of the Robotics and Automation were recognized.

Following the meal and awards, former NASA chief administrator Richard Truly made brief remarks on the need for appropriate blending of human and robotic operation in space.

BEST CONFERENCE PAPER
Brenan J. McCarragher, Australian National University, and Haruhiko Asada, Massachusetts Institute of Technology, received the award for their paper, "A Discrete Event Approach to the Control of Robotic Assembly Tasks". Other finalists were

- H. Peremans and J. vanCampenhout, University of Ghent, Belgium, "Tri-Aural Perception on Mobile Robot"
- J.W. Burdick and J. Radford, California Institute of Technology and G.S. Chirikjian, Johns Hopkins University, "A 'Sidewinding' Locomotion Gait for Hyper-Redundant Robots
- J. Hyde and M. Cutkosky, Stanford University, "Contact Transition Control: An Experimental Study."

ANTON PHILIPS PRIZE

Ning Xi, a D.Sc. candidate in Systems Science and Mathematics at Washington University was awarded the Anton Philips Award for the Best



BEST CONFERENCE PAPER: Brenan J. McCarragher and Haruhiko Asada



ANTON PHILIPS AWARD FINALISTS: James F. Watson, Paolo Fiorini, and Ning Xi

Student Paper. James C. Schmit of Philips Laboratories presented the award, Xi's paper, "Event-Based Planning and Control for Multi-Robot Coordination" was coauthored with T.J. Tarn, Washington University, and A.K. Bejczy, Jet Propulsion Laboratory. Other finalists were

- Kevin M. Lynch, Carnegie Mellon University: "Pulling by Pushing, Slip with Infinite Friction, and Perfectly Rough Surfaces", M.T. Mason, Co-author
- Paolo Fiorini, University of California, Los Angeles: "Motion Planning in Dynamic Environments using the Relative Velocity Paradigm", Z. Shiller, Co-author

•James F. Watson, Rensselaer Polytechnic: "A Bottom-up Algorithm for State-Space Size Estimation of Petri Nets", A.A. Desrochers, Coauthor

•BEST VIDEO

"Brachiation Robot" by Fuminori Saito and Toshio Fukuda, Nagoya University, was named the best video submission. Other finalists were

 S-R. Oh, R.L. Hollis, and S. E. Salcudean, IBM Thomas J. Watson Research Center, "The Magic Wrist: Compliant Assembly Using Magnetic Levitation"

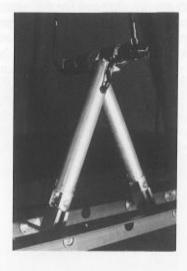


LOOKING AHEAD: Bill Gruver, 1994 ICRA General Chair and Harry Stephanou, 1994 ICRA Program Chair



BEST VIDEO: Toshio Fukuda and Fuminori Saito

- David E. Orin and Ho Cheung, Wong, The Ohio State University, "Quadruped Standing And Running Jumps"
- Dr. Ronald Lumia, National Institute of Standards and Technology "Triclops: A Tool For Active Vision"
- A. A. Rizzi and D. E. Koditscheck, University of Michigan, "Dynamically Dexterous Robotics: The Two-Juggle"
- Kazuya Yoshida, Tokyo Institute of Technology "Experimental Free-Floating Robot Satellite Simulator"



Fukuda/Saito "Brachiation Robot"

A Discrete Event Approach to the Control of Robotics Assembly Tasks (Best Conference Paper)

Brenan J. McCarragher and Haruhiko Asada

Abstract

A new approach to process modelling, task synthesis and motion control for robotics assembly is presented. Assembly is modelled as a discrete event dynamic system using Petri nets, incorporating both discrete and continuous aspects of the process. To accomplish a desired trajectory a discrete event controller is developed. The controller issues velocity commands that direct the system toward the next desired contact state, while maintaining currently desired contacts and avoiding unwanted transitions. Experimental results are given for a dual pegin-the-hole example. The experimental results not only demonstrate highly successful insertion along the optimal trajectory, but also demonstrate the ability to detect, recognize and recover from errors and unwanted situations.

Event-Based Planning and Control for Multi-Robot Coordination (Anton Philips Student Paper Prize)

Ning Xi, T.J.K. Tarn, and A. Bejczy

Abstract

There has been an increasing interest in the development of intelligent planner and controller for multi-robot systems. A new planning and control scheme for multirobot coordination is presented. First, the event-based motion reference is introduced. It drives the system to achieve an optimal coordination. Unlike the traditional motion trajectory plans, which are functions of time, the new plan is referenced to events related to the system actions. As a result, the planning becomes a closed-loop real-time process. Therefore, the planner has an ability to handle some unexpected and uncertain events. After introducing the general task space concepts and combining with nonlinear feedback technique, hybrid position/ force controllers are designed. The structure of the controllers are not changed for different tasks. To improve the performance of force control, the dynamics of joint motors is considered in the force control. For a given task, a task projection operator can be found for each robot with the consideration of redundancy management. The event-based planning and control scheme naturally lends itself to a distributed computing architecture. A multi-processor shared memory architecture is proposed to implement this scheme in a parallel computation. The event-based coordination scheme was experimentally implemented and tested for the coordinated control of two 6-DOF PUMA 560 robots with excellent results.

Comments on Floppy Disks and CD ROMs for the Proceedings of 1993 IEEE Conference on Robotics and Automation •1. The service of providing floppy disks for the 1993 Conference is useful, because I will use them often useless, because I will never use them In the next year or so, the Conference (should) (should not) provide floppy disks like the ones this year 3. The Conference (should) (should not) replace the traditionally printed Proceedings by CD ROMS. OTHER COMMENTS Name: Date Address Telephone Fax Email: Please mail the completed form to J.S. Luh Dept. of Electrical & Computer Engineering 221 Riggs Hall Clemson University Clemson SC 29634 USA email: luhj@prism.clemson.edu fax: (803)656-2698

Industry/Government/University Cooperation

Rosalyn Snyder

This panel discussion was organized by the Industry, University, and Government Cooperative Technical Committee and led by Patrick Eicher of Sandia National Laboratories, the IUGC TC chair.

Jokes about the feeding frenzy sparked by the Clinton administration's announcement of a multi-billion dollar research initiative for defense conversion and dual use technology, expressions of confusion and concern about the reordering of U.S. research funding priorities, and lots of ideas about how to improve communication between the academic, government, and commercial sectors all came up in a lively panel discussion at ICRA93 sponsored by the Industry, University, and Government Cooperative Committee of the Robotics and Automation Society.

With non-U.S. nationals representing approximately a third of both RA society membership and ICRA attendance, the panelists emphasized the interdependence of the global economy and noted that because of the size of the United States, economic problems in U.S. have an adverse effect on other economies. Because of the international nature of the Robotics and Automation research community, society members have extensive expertise in private, government and university research infrastructures worldwide. Multi-national R&D projects in areas as diverse as inspection of roads and bridges to oceanic exploration address problems which have no national identity.

The panel chair, Patrick Eicker, of Sandia National Laboratories, emphasized the need for people to translate what's going on in academia to the industrial community. The Video Conference Proceedings can be one means of showing

research to industry managers in terms relevant to them. He described one role of Sandia and other national laboratories as "halfway houses" to bridge the gap between the universities and the private sector. Norman Caplan of the Engineering Directorate of the National Science Foundation described the current situation as a paradigm shift, which is brand new and will be shifting for quite a while as we head away from complete separation of government and industry toward a proactive role by the federal government in the industrial sector.

Engineering research in the U.S. in the past has focused on defense and space because the Department of Defense has been the largest customer and therefore has dictated the direction of research through RFPs. The NSF has traditionally had a much smaller budget, but has the advantage of greater flexibility to fund "curiosity-driven research" and to emphasize education and human resources. However, recently, executive committees such as FCCSET — the Federal Coordinating Committee for Science Education and Technology, which have had charters but no money for some time, have obtained funding from Congress and their impact is becoming noticeable. Among the emphases of FCCSET are Agile Manufacturing, Quality Manufacturing, the Environment and Biotechnology. NORTCO (National Ocean Technology Research Corporation) may be typical of future mechanisms for government involvement in longterm high risk R&D projects in this case, utilization of coastal ocean resources for clean energy from wave motion and thermal gradients and food production through mariculture.

Peter Luh of the University of

Connecticut described the principles of agile manufacturing, which emphasizes flexibility, speed and accuracy in equal measure. Commitment to agile manufacturing requires fundamental changes in the way things are made, changes perhaps as drastic as those imposed by the introduction of the assembly line. Those who are able to rise to the challenge will reap the very tangible benefits of successfully meeting the customer's needs on demand. Luh emphasized the need for researchers to take advantage of emerging technology and to improve the process of getting industrial participation in the research process. Videos, which can be used to show the development of a concept from pen and paper to a prototype model, can be useful tools to show managers of the relevance of basic research to their goals.

Luh pointed out that many government funding programs, including the \$1.5 billion U.S. Technology Redevelopment Program, require university/industry collaboration. This requirement has the goal of insuring communication between the two groups through the research, development and deployment of new technologies.

However, when economic pres-



Pat Eicher and Peter Luh

New Titles

Kluwer Academic Publishers. 101 Philip Drive. Norwell MA 02061 Tel: (617) 871-6600

Robot Learning. Jonathan H. Connell and Sridhar Mahadevan, eds. T.J. Watson Research Center, IBM. 1993. Detailed experimental results from a number of real robot systems developed at universities and research labs including MIT, CMU, Brown, University of Texas-Austin, Rochester and IBM. Includes new, unpublished material and a bibliography. ISBN 0-7923-936501

Neural Network Perception for Mobile Robot Guidance. Dean Arthur Pomerleau, Carnegie Mellon University. 1993. Explore the connectionist system of ALVINN (Autonomous Land Vehicle In a Neural Network) that overcomes the diversity and real time constraints inherent in vision-based mobile robot guidance. ISBN 0-7923-9365-1

AK Peters Ltd. 289 Linden St., Wellesley MA 02191 617-236 -2101

Mobile Robots: Inspiration to Implementation. Joe Jones, IS Robotics, and Anita Flynn, MIT AI Lab. May 1993. A guide to building mobile robots with a progression of design project of increasing complexity. ISBN 1-56881-011-3

Technical Reports. The Robotics Institute, Carnegie Mellon University, Pittspurgh PA 15213 3890 CMU-RI-TR-92-10 Serpentine Manipulator Planning and Control for NASA Space-Shuttle Payload Servicing, H. Herman, H. Schempf CMU-RI-TR-92-12 Fuzzy Control and Fuzzy Kinematic Mapping for a Redundant Space Robot, A. Schacherbauer, Y. Xu

CMU TR-92-13 RACCOON: A Realtime Autonomous Car Chaser Operating Optimally at Night, R. Sukthankar

CMU-RI-TR-92-16 Third Annual Report for Perception in Outdoor Navigation, C. Thorpe, T. Kanade, et al. CMU TR- 93-01 Hidden Markov Model Approach to Skill Learning and its Application to Telerobotics, J. Yang, Y. Xu, C.S. Chen

CMU-RI-TR- 93-02 Fuzzy Inverse Kinematic Mapping: Rule Generation, Efficiency and Implementation, Y. Xu, M.C. Nechyba CMU-RI-TR-93-03 The Terregator Mobile Robot, L. Champeny -Bares, S. Coppersmith, K. Dowling

Coppersmith, K. Dowling
CMUTR-93-04 Video Applications
Development Platform, R. Thibadeau,
R. Berger, D. Touretzky, D.Lindsay
CMU-RI-TR-93-05HSTS:Integrating
Planning and Scheduling, N.
Muscettola

CMU-RI-TR-93-06 An Experimental Analysis of Bottleneck- Centered Opportunistic Scheduling, N. Muscettola

CMU-RI-TR-93-07 Depth from Focusing and Defocusing, Y. Xiong, S. A. Shafer

CMU-RI-TR-93- Backtracking Techniques for Hard Scheduling Problems, N.Sadeh, K. Sycara, Y. Xiong CMU-RI-TR-93-09 Panacea: An Active Sensor Controller for the ALVINN Autonomous Driving System, R. Sukthankar, D. Pomerleau, C. Thome

CMU-RI-TR-93-10 Massively Parallel, Adaptive, Color Image Processing for Autonomous Road Following, T.Jochem, S.Baluja CMU-RI-TR-93-12IR- RAT: Infrared Remote Activity Transceiver-Universal Model, W. Sands, R. Thibadeau, D.Anderson

CMU-RI-TR-93-14 Segmenting Textured 3D Surfaces Using the Space/Frequency Representation, J. Krumm, S. A. Shafer

THESIS: System for Automated Fixture Planning with Modular Fixtures, K.H.Kim

THESIS: Agent Design for Automatic Use of a Software System: A Case Study with a Soar Agent for Mathematica, D. K. Pathak

ICRA93 Panel Discussion

sures cause companies to "rightsize" (i.e., cut staff), and large companies reduce their R&D staff and smaller companies give up the hope of acquiring such "luxuries". Academic researchers must make good use of this opportunity to become "relevant". They, however, have to avoid the temptation to follow the demand for research on "relevant problems" to the extent that they abandon the cutting edge altogether.

The major role of the academic researcher is not to solve the problems which plague industry today. Those in the private sector will do that out of necessity themselves. The private sector needs and expects academic researchers to look ahead and work on solutions to problems that are going to pop up six months or six years down the road.

In the absence of functioning crystal balls, researchers need to spend the necessary time and effort to learn the real needs of industries, especially those needs that may be

laying in wait pending the solution of the immediate crisis.

The approximately 50 ICRA participants who attended the panel

discussion took an active role. Some comments in the discussion were repeats of those at every RA conference for the last 10 years—the difficulties of crossing the barrier between research and application, the emphasis by U.S. industry on quarterly profit/loss statements which almost preclude long range R&D, and the publish or perish university tenure requirements that give little time or incentive for efforts at technology transfer. Nevertheless, there was a sense of excitement, optimism and purpose among the speakers that indicated a belief that after ten years and more, people outside the Robotics and Automation Society might finally be listening.

Note: For more information about the U.S. Dual Use Research Initiatives, call 1-800-DUALUSE. The deadline for SBIR proposals under the Dual Use Initiative is September 16.

The IEEE in the 21st Century: The IEEE Strategic Plan

Since August 1992, the Strategic Planning Committee and selected IEEE volunteer and staff leaders have been preparing a longrange IEEE Strategic Plan. Part I of the draft Plan will be distributed to the general membership with the IEEE Institute. Members can obtain copies, offer suggestions and comments via email to strategy@ieee.org or by writing Committee Chair Henry L. Bachman, IEEE Headquarters, 345 East 47th Street, New York, NY 10017.

The eight primary goals as stated in the preliminary document are:

•Goal 1— Globalization:

Make the IEEE a truly global organization, characterized by (1) decentralized volunteer and staff leadership working cooperatively around the world, (2) collaborative relationships with national electrotechnical societies, and (3) involved members from all areas of the world.

- Objective 1A—Achieve international recognition of the IEEE as a global organization, complementary to the various national technical and professional societies.
- Objective 1B—Substantially increase IEEE membership in all areas of the world that have a significant capability in electrotechnology.
- •Goal 2—Information Exchange:
 Establish the IEEE as a leader in
 the use of technologies for highspeed communications to disseminate information products and
 services, enhance technical interaction among members, and
 improve organizational communication among the professional
 staff and volunteers
- Objective 2A—Develop an electronic communication infrastructure that will effectively support the dissemination of information products and services and that will also enhance

- the exchange of information among members, volunteers, and staff around the world.
- Objective 2B—Provide interactive electronic access to IEEE services such as membership and subscription renewal, conference registration, electronic networking, bulletin boards and forums.
- •Goal 3— Products and Services:
 Move expeditiously to the electronic dissemination of existing IEEE products and services; systematically identify opportunities for expanding the product line to take full advantage of the electronic media and broaden the markets for the Institute's products and services
- Objective 3A—Make all IEEE information products available in electronic form as quickly as possible.
- Objective 3B—Develop a business model that will aid in making sound decisions leading to sensible pricing of products so as to produce adequate income and ensure worldwide distribution
- Objective 3C—More closely match IEEE products and services to the needs of members and nonmember customers worldwide, with special emphasis on the practical applications of electrotechnology and environmental concerns.
- Objective 3D—Create a system of distributed data bases to provide customized access to IEEE information such as technical articles, complete journals, continuing education products, product catalogs, a calendar of events, news bulletins, and personnel directories.
- Objective 3E—Position the IEEE as the premier publisher of books on electrotechnology and as the publisher of choice for memberauthors.
- Objective 3F— Provide an extensive menu of competitive non-technical products and services to meet the personal needs of members.

•Goal 4—Standards:

Achieve and maintain recognition of the IEEE as a leader in the timely generation and dissemination of international electrotechnology standards that promote expansion of the industrial base in which IEEE members are employed.

- Objective 4A—Make the IEEE a major force in the development and publication of standards and related information that serves the needs of the international electrotechnical community
- Objective 4B—Ensure that the Institute's standards development and distribution processes remain financially sound as electronic dissemination becomes predominant.

Continued on page 21

The IEEE Globalization Report

The IEEE Ad Hoc Committee for the Development of a Global Institute is now publishing an electronic newsletter to focus on the international activities of the Institute. H. Troy Nagel, President -Elect is executive editor.

Those wishing to contribute articles should send via e-mail to Barbara Ettinger, managing editor: b.ettinger@ieee.org. To subscribe to the IEEE Globalization Report

- *send an email message to: listser@info.ieee.org. (The subject field is irrelevant. Enter anything)
- On the first line of the message, enter the following command: sub global.news [address]

The Space Robot Technology Experiment Rotex

Gerhard Hirzinger German Aerospace Establishment (DLR)

ROTEX was part of the Spacelab Mission D2, on the shuttle flight STS 55 Columbia, April 26-May 6, 1993)

For the first time in the history of space flight a small, multisensory robot (i.e. provided with modest local intelligence) has performed a number of prototype tasks in most of the different operational modes that are feasible today; namely preprogrammed (and reprogrammed from ground), remotely controlled (teleoperated) by the astronauts using a control ball and a stereo-TV-monitor, and remotely controlled from ground via the human operator as well as via machine intelligence. In these operational modes the robot successfully closed and opened connector plugs (bayonet closure), assembled structures from single parts and captured a free-floating object. Particularly spectacular these pictures went around the world— was the fully automatic grasping of the free-flyer from ground (based on real-time image processing out of the hand cameras) despite an overall signal delay of more than 6 seconds.

ROTEX Technologies
The success of ROTEX is due

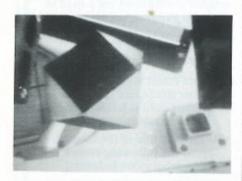


Photo taken by one of the robot hand cameras of the free-floating object seconds before capture by the ROTEX hand. (Photo courtesy DLR)

in large part to several key technologies:

•Multisensory gripper:

With 16 sensors (e.g. a stiff and a more compliant optical forcetorque-sensor, 9 laser range finders, a stereo camera and tactile arrays) and more than 1000 electronic components, the ROTEX gripper presumably is the most complicated robot gripper built to date. Nevertheless, it worked perfectly during the mission. None of the sensory systems heated up beyond 38° C, although they were designed for up to 70° C. The stereo images from the hand camera as well as those from the workcell camera were impressive.

Local (shared autonomy) sensory feedback control:

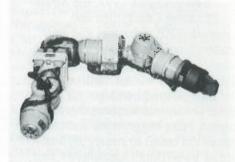
The on-board robot was able to refine gross commands autonomously by intelligent sensory processing

Predictive simulation:

The powerful delay-compensating 3D-stereo graphic simulation included the robot's sensory behavior, enabling the robot and its operators to overcome the 6+ second signal delay.

In addition to the overall performance observations, the initialization phase showed interesting effects when different joint control parameters were uploaded, one of them bringing the robot near to stability margin. Due to the lack of gravity, the joints had no preloading. Thus the controllers had to compensate for backlash effects, etc.

In-flight-calibration of the robot using the finger-tip laser range finders improved its positioning performance.



The ROTEX Arm (Photo courtesy DLR)

The experiment also clearly showed that the ground control structures for future space robot applications should be *radically* changed, to allow the robot operator on ground direct access to the different types of uplinks and providing him with a continuous TV-transmission link.

Close cooperation between man (astronaut or ground operator) and machine comprising different levels of robot autonomy was the basis of the success of ROTEX. It was clearly proven that a robot system configured in this flexible arrangement of arbitrary and fast switching between the most different operational modes will be a powerful tool in assisting man in future space flight projects. It was impressively shown that even large delays can be compensated by appropriate estimation and pre-simulation concepts. Technology Transfer

A number of terrestrial spin-off effects of DLR's (German Aero-

Continued on page 21



Gerhard Hirzinger

An Open Architecture Industrial Robot Controller

F. Dogliani, G. Magnani and L. Sciavicco

Modern industrial robot controllers are powerful multiprocessing computing machines, rather flexible for application development thanks to powerful programming systems. For cost reasons, however, they have very compact and optimized hardware and software architecture.

The need to compare most interesting "modern" control concepts and algorithms, proposed by academic and research community, with "classical" algorithms, implemented today in most industrial controllers, is clearly recognized in both academic and industrial worlds. However, experimenting with new control concepts or algorithms is a prohibitive undertaking even to skilled users. Documentation and software development tools that should be available to the user who

is interested in such experimentation usually represent proprietary knowhow that robot manufacturers do not disclose.

In view of this, the Italian National Research Council, in the frame of the national research program on robotics, Progetto Finalizzato Robotica, promoted in 1990 a research project aimed to develop an "open" version of an industrial robot controller suitable for the evaluation of "modern" control algorithms and concepts. Evaluation means to measure performances, requirements in terms of computing power, and most important from an industry point of view, robustness, reliability, and ease of tuning.

Various operating teams were involved in the project. From the industrial side were COMAU SpA

(FIAT group), the Italian leading company on robot manufacturing and factory automation, and Tecnospazio SpA (joint consortium of COMAÜ and FIAR SpA) Italian leader in space robotics. From the academic side were Politecnico di Milano (Prof. Maffezzoni), Universita' di Napoli (Prof. Sciavicco), Universita' di Roma "La Sapienza" (Prof. Nicolo') and Universita' di Roma "Tor Vergata" (Prof. Nicosia).

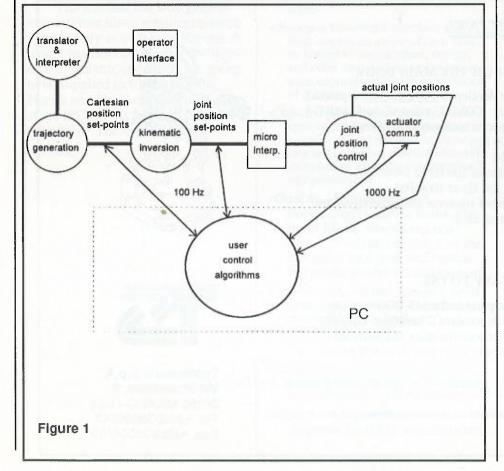
The requirements for the open controller were defined jointly by the teams. Then, while the academic research teams focused on design and software implementation of control algorithms, the industrial teams started the design of modification to be introduced on the C3G-9000, the state of the art industrial controller manufactured by COMAU.

The C3G-9000 is a VME-busbased system comprising two processing boards: the Robot CPU (RBC) and the Servo CPU (SCC).

The RBC board is equipped with Motorola 68020/68882 CPUs and with a shared memory area that can be accessed from the RBC itself as well as from other boards on the VME-bus. Tasks running on RBC accomplish user interface functions and translation and interpretation of the user's programs. The RBC drives the Operator Control panel and the programming terminal.

The SCC is a multiprocessing board with Motorola 68020/68882 CPUs and with Texas DSP. Its main functions are trajectory generation,

F. Dogliani is with COMAU Robotics, Strada Orbassano, Beinasco (Turin) G. Magnani is with Politecnico di Milano, Piazza Leonardo da Vinci 32, Milan (formerly Tecnospazio SpA, via Mercantesse 5, Bollate (Milan)) L. Sciavicco is with Universita' di Napoli, Via Claudio 21, 80125 Naples



both in joint and Cartesian space, kinematic inversion, micro interpolation, joint position servo-control. Trajectory knot points are updated each 10 ms, while the position servo-loops sampling time is 1 ms.

Other boards are fitted in the system for safety functions AND digital and analog I/O.

The C3G - OPEN controller

Thanks to the standard VMEbus, it is easy to perform a tight hardware integration of commercial hardware in the controller. Of course the difficult task concerns the communication and synchronization of external software processes with controller processing and functions.

As far as the hardware is concerned, the choice was to establish a bus-to-bus communication link between the C3G control unit and a standard Personal Computer. The link is established by a bus-to-bus communication adapter BIT3, consisting of two boards to install in the VME an in the PC bus respectively and connected via a parallel commu-

nication cable.

The PC and the C3G communicate by the shared memory on the RBC. Time synchronization is implemented by interrupt signal from C3G to PC. The interrupt starts the PC operating cycle, consisting of reading data from the shared memory, executing control algorithms, writing computed variables (to be actuated by the C3G itself) in the shared memory.

User control algorithms running on the PC may interact with C3G algorithms at different levels, according to chosen operating mode; data exchanged by the C3G and the PC will vary consequently. Figure 1 is a functional description of controller showing interaction and data exchange points between controller and PC software.

User control algorithms may interact with standard control algorithms either at trajectory generation level or at joint control level.

At the trajectory generation level, the user interface facilities of

the C3G still remain active, and therefore they may be exploited to program robot tasks. The control algorithms on the PC may read both Cartesian (T6 matrix) and joint position and velocity set-points computed by C3G and may overwrite them. Actual command signals and joint positions may also be read, and an offset to the command signal be written.

At joint control level the PC reads measured joint positions and writes the actuator command signals (motor current set-points). Therefore the PC control algorithms completely replace the C3G algorithms.

Data exchange at joint level is at the frequency of 1 KHz, high enough for the fastest control algorithms, while at trajectory generation level it is at 100 Hz.

A test-bed for advanced robotic controls

A test-bed was installed at Tecnospazio laboratories (Milan), made up of the C3G-OPEN (with a COM-

'PC-C3LINK'

GET INTO ROBOTICS THROUGH THE MAIN DOOR

TECNOSPAZIO and COMAU have developed <u>'PC-C3LINK'</u>, a product that offers you a total control on every COMAU robot of the SMART-3 family. With <u>'PC-C3LINK'</u> you can access such robot variables as:

- Cartesian set-point (at 100 Hz)
- joint set-points (at 100 Hz)
- motor shaft positions (either at 100 Hz or 1000 Hz)
- motor currents (either at 100 Hz or 1000 Hz).

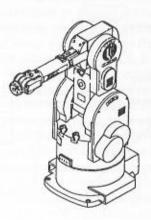
This makes it possible to try on the robot whatever advanced algorithm you like (force control, dynamic control, etc.)

POWERFUL AND EASY TO USE

<u>PC-C3LINK'</u> runs on a Personal Computer under MS-DOS™ and let you implement your own algorithms in standard C language. Data can be collected during each test you perform on the robot and analyzed immediately afterwards with your favorite tools, such as MATLAB™, MATHEMATICA™, etc.

For further information please contact Mr. M.Fenzi or Mr. A.Carozzi.

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Tecnospazio S.p.A. Via Montefeltro, 8 20156 MILANO - Italy Tel. +39/2/38005049 Fax. +39/2/38004469 PAQ 486 M50 - 50 MHz PC) and of a SMART 6.12R COMAU robot equipped with commercial force sensor (linked through serial and parallel lines to the PC). Various experiments have already been performed on it by academic and industrial teams. For instance feed-forward model-based, learning and hybrid control algorithms have been implemented. results will be presented to the next robotics and control community conferences.

The PC represents a powerful, easy and well-known programming environment, very rich with development tools and data analysis software. Modification of control algorithms is easy when programming with a high level language on a PC. Furthermore the PC may be easily connected to external sensors (e.g. force/torque sensor) and systems through standard interfaces at very low cost.

Altogether the test-bed combines the advantages of a powerful research tool and a system composed of fully standard industrial components.

The test-bed has won general interest from many robotics research units in Italy as well as in Europe. A model has been supplied to Politecnico di Milano, and others are going to be supplied to Universita' di Napoli and European Space Agency at the ESTEC Technology Center (Nordwijk, The Netherlands).

G. Hirzinger: The Space Robot Technology Experiment Rotex (from p.18)

space Research Establishment)
space robotics work are already visible today. Just to mention one example: The 6 dof hand controllers
(control balls) used during the mission by astronauts and ground-teleoperators have been redeveloped into a space control mouse for 3Dgraphics, and are now distributed and manufactured under license by

the company LOGITECH.

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IEEE Strategic Plan (from p.17)

·Goal 5— Education

Ensure that IEEE members have convenient and affordable access to comprehensive learning experiences that will enable them to continually update their professional competencies; enhance the IEEE's positive influence on the quality of engineering education at all levels.

- Objective 5A—Assure that IEEE members have access to affordable, highquality continuing education programs throughout their careers.
- Objective 5B—Achieve greater influence in determining standards for electrotechnology education worldwide
- Objective 5C—Make members and their employers aware of their common need to commit time, energy, and other resources to assure continuous improvement in the competence of individuals and organizations.
- Objective 5D—Become a major influence on teachers, school guidance counselors, and students in elementary and secondary schools who seek information about the electrotechnology professions.
- Goal 6— Public Support
 Foster improvements in the quality of life by advocating economic development based on the electrotechnologies and increasing public awareness and support.
- Objective 6A—Foster economic development by promoting the advancement of electrotechnology.
- Objective 6B—Promote public technological literacy
- •Objective 6C—Improve the general public's image of the electrotechnology profession and its practitioners.
- •Goal 7— Organization
 Improve the IEEE organizational

structure and business practices to take greatest advantages of available resources and ensure costeffective responsiveness to member and customer needs.

- Objective 7A—Enhance commitment to excellence of service for members and customers in all technical and geographic areas
- Objective 7B—Reduce barriers between the IEEE's many organizational units and increase productivity by fostering innovation and interunit cooperation.
- Objective 7C—Make the greatest possible use of the expertise, energy, and dedication of the IEEE staff and volunteer leaders by creating an energizing, supportive working environment.
- Objective 7D—Develop methods for ensuring the continuity of IEEE operations.
- Objective 7E—Ensure that the professional career needs of the Institute's U.S. members are satisfied in a manner complementary to the Institute's globalization goals.

•Goal 8— Finance

Maintain a sound financial position that reduces dependence on member dues, ensures efficient management and use of financial resources, and supports the Institute's global objectives.

- Objective 8A—Develop a long-term financial management strategy for the Institute that addresses all present and anticipated needs.
- Objective 8B—Optimize the management and use of the Institute's financial and human resources
- Objective 8C—Identify and implement new income-generating programs and activities

From Robots to Design

Daniel E. Whitney Draper Laboratory

The following is a summary of Whitney's Keynote address at The 1993 IEEE Robotics and Automation Conference, Monday, May 3, 1993

This talk will challenge the **IEEE Robotics and Automation** Society to ask itself if it pays enough attention to the Automation part of its name. The trend at the annual conferences as well as in the Journal has been to emphasize Robotics and de-emphasize Automation. Since there are many benefits to be gained from the combination, I will try to make this case by example as well as with some history.

A Little History

It is useful to begin by recalling last year's Keynote address, given by the director of the French Space Agency. His argument ran more or less as follows: due to the sharp and unstoppable rise in the computing power of microprocessors in relation to their price, weight, and power consumption, it is inevitable that computers and robots will replace men in space. At the very moment he was speaking, Space Shuttle astronauts were in the process of abandoning their attempt to retrieve a satellite using the Shuttle's Remote Manipulator System and preparing to retrieve it by hand. Why did this happen?

There seem to be two reasons: first, there was little documentation on the satellite itself in the region where it was supposed to be grasped. Second, it was not designed to be grasped in space, although subsequent satellites are. The failure therefore was not a failure of robotics but rather a failure of robotics

and automation.

Here is another vignette from last year's conference: at the tutorial session on assembly planning. The chairman said that assembly planning is a subset of planning, which makes it a subset of artificial intelligence. Whereupon every speaker thereafter said that assembly planning was a subset of product design, a very different view.

This vignette nicely captures the difference in viewpoint between "pure" robotics and the union of robotics and automation. Such differences have often led to radically different perceptions of what robots would be able to achieve in actual

use in manufacturing.

The "AI view" of the robot as a substitute person has not been borne out in industrial practice, mainly for the reason that it sees the robot as an isolated entity that should be able to function independently of its environment and therefore can be conceived and designed independently of it. The failure of the Shuttle manipulator to retrieve the satellite in May 1992, in spite of excellent training and arduous efforts by the astronauts, is evidence of the weakness of the "AI view."

The differences between the "AI view" and the "product design" view can be further illustrated by the Alvey Demonstrator project, a European Community program in the mid 1980s that attempted to create a factory robot that could plan its own assembly work. The presumed scenario was that the robot would receive a group of parts and, even if not all the necessary parts were present, would seek a suitable plan and assemble as many of them as possible, setting the unfinished assembly aside until the rest of the parts arrived, and working on something else in the meantime.

Is this a reasonable scenario? Consider what will happen: either the rest of the parts will arrive in a few seconds, in which case the robot should just wait until all are present and then use the optimal plan; or else the missing parts will not arrive for some minutes or hours, in which case it is again better to wait since because assembly usually takes only a few seconds per part anyway - in that length of time other useful work can be started and completed. Otherwise, if many incomplete items are made, the room will soon fill with unfinished assemblies, using space and fixtures, causing bookkeeping problems, and so on. Therefore, in either case it is better to wait until all the parts are present. Note that this line of reasoning does not need to consider the robot's skill as an assembly planner. The reasoning is based entirely on the characteristics of the robot's environment. The moral, repeated many times in practical robotics, is that only the robot plus its environment is worth thinking about. Neglecting the environment removes many necessary constraints and makes valid conclusions hard to obtain. Automation is a valid and valuable environment to use for this purpose.

My Own View

I have come to this way of thinking by the route of research into robot assembly, which resulted in an appreciation for the value of understanding the requirements on robot actions that are imposed by the parts being assembled. Part mating theory led to the conclusion that in many common and important cases, parts will almost assemble themselves as long as they are gripped properly and the initial errors between them lie within certain bounds. This aspect of the theory might well be called "assembly in the small" to distinguish it from "assembly in the large" which I will define shortly.

At this same time (mid 1970s) there was a great deal of optimism about robots in industry. This optimism faded to disappointment soon

after as people realized that robots were too slow and cost too much, and more importantly that products were not designed properly for robot assembly. The essential fit of robot plus environment (in this case the environment is a properly designed product) was not there.

It is now 15 years later and we know better. To create the successful robot assembly systems we see today (20 robots in a line at Sony each assembling 5 complex parts to VCR tape decks or 80 robots in a series of lines assembling all the complex subassemblies of Polaroid cameras) required complete rethinking of both products and robots. This rethinking can be called assembly in the large. While assembly in the small is a relatively controllable physics problem, assembly in the large is a system problem that combines robots, economics, detailed product design and overall product architecture. Arriving at the understanding we now have and extending it further require retaining that system view.

A Focus on Assembly

I want to dwell on assembly for a while because it illustrates these system issues so well and points to several ways that robotics and automation could come together more productively in the future. Assembly is compellingly interesting physically, logistically, and from the point of view of the product's function.

Many of the issues presented by assembly can be addressed by skills and techniques developed in robotics theory, such as kinematics, algorithms, coordinate transforms, and data structures. In one sense, everything in manufacturing happens during assembly. This is where a product comes to life, inasmuch as single parts usually perform no functions.

The links between parts often trace functional links: (assembly description) the motor is attached to the shaft which is attached by rack and pinion to the load; (functional description) when the motor turns, the load moves.

Furthermore, products can be thought of as members of families, and the architecture of the product can determine how to plan assembly

so that it is easy to generate whatever family member is needed on a Just in Time basis. A number of engineering and database problems come together here, such as part tolerance stackups, part-whole relations, combinatorics, and so on.

More generally, assembly in the large permits us to see assembly in many roles other than mere part mating. These include logistics, resource mobilization, the ability of a factory to respond to outside forces, and enterprise integration. With this view in mind, one can see new ways to design products to enhance manufacturing flexibility.

Consideration of assembly may spawn ways to capture product function and relate it to product geometry during design. Finally, it may show the need for new kinds of product design tools that take account of assembly and prepare products for flexible assembly by robots.

Examples of Assembly in the Large

The examples that follow are Japanese shipbuilding, assemblydriven product design and manufacturing, and Feature-based Design for Assembly.

Japanese shipbuilding:

In the 1950s and 60s, several Japanese shipbuilding companies extended Henry Kaiser's modular shipbuilding methods from the 1940s beyond structural modules. In the Japanese method, everything became a module: structure, pipe, ventilation, larger and larger pieces of the ship, and more complete pieces that had all their interior equipment installed in the shop before being joined to the ship. Not only did every part of the ship become a module, but the shipyard's shops, equipment, and work crews became modules as well. The principles of Group Technology and Statistical Process Control were combined to create an integrated design and manufacturing method that was based on assembly as the main production step.

Assembly-based manufacturing:

This is a term I have coined to describe another Japanese company's flexible production methods. The company is Nippondenso, and the issue is to make assembled products to order by the Just in Time method in response to unpredictable

JAPANESE SHIPBUILDING

MODULAR DESIGN AND CONSTRUCTION, OUTGROWTH OF KAISER MODULAR STRUCTURE OF 1940S

JAPANESE METHOD COMBINES DESIGN OF SHIP BY MODULES (TRUE DISASSEMBLY METHOD) WITH DESIGN OF SHIPYARD AND WORK MANAGEMENT



DESIGNER'S VIEW

IT'S A MODULE: ALL THE PARTS TO MAKE A LITTLE FULLY WORKING PART OF THE SHIP



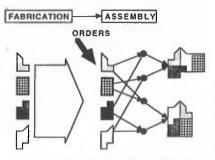
MANAGER'S VIEW

IT'S A WORK PACKAGE:

ALL THE WORKERS, TOOLS, PARTS, PLANS, AND SKILLS NEEDED TO MAKE A FULLY WORKING PART OF THE SHIP



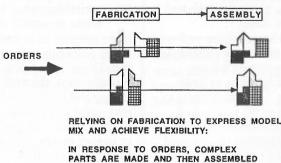
Figure 1. Illustration of Modular Shipbuilding. On the left side is the designer's view of a complete module of the ship, including all the parts, fully installed, painted, tested, and ready to be joined to similar modules on the ship. On the right is the manager's view, a work package complete with plans, tools, parts, and worker skills needed to make the module.



RELYING ON ASSEMBLY TO EXPRESS MODEL MIX AND ACHIEVE FLEXIBILITY:

SIMPLE PARTS ARE MADE TO STATISTICAL TRENDS. IN RESPONSE TO ORDERS, ITEMS ARE ASSEMBLED.

THIS IS A HIGH BANDWIDTH METHOD BECAUSE ASSEMBLY HAPPENS SO QUICKLY.



INTO FINAL ITEMS.

THIS IS A LOW BANDWIDTH METHOD BECAUSE FABRICATION TAKES SO LONG.





Figure 2. The Difference Between Fabrication-driven Manufacturing and Assembly-driven Manufacturing

orders from Toyota. The method one might normally use is to make a wide variety of complex parts that each contain the different features Toyota needs, and put them together when they are needed. Since fabricating parts generally takes hours or days, this method will have a difficult time responding if changes in the order pattern occur several times a day. Nippondenso's method is to make a larger number of simpler parts that have to be assembled together in order to perform the desired function. Combining the right version of each of the simple parts creates the particular function needed. Large numbers of these parts are made in advance based on the statistical patterns of recent orders. They can then be quickly assembled into the items Toyota actually orders.

Feature-based Design for Assembly

FBD-A is a new approach to product design and CAD that combines part geometry and assembly by permitting the designer to designate regions on parts that will assemble to corresponding regions on other parts. FBD-A thus links product design with individual part design

PARTS, ASSEMBLIES, AND DATA ATHOM Assembly TOOL 0 0= STRUCTURED DESIGN FOR REDICTION SUBASSEMBLY DEFINITION GEAR MATE GEAR CASE DESIGN FOR EVALUATION DRAPER @

Figure 3. Illustration of Feature-Based Design for Assembly. On the left, the designer creates individual parts from arbitrary geometry plus assembly features. Both the fabrication and assembly aspects of these features can be considered at this time using special design software. As the parts are designed and their assembly features are linked, a database can be built up that captures the assembly information concerning which parts assemble to each other, how the parts are located relative to each other, and what kinds of assembly actions are needed to mate them. On the right, the issues surrounding assembly of pairs and groups of parts can be considered, such as breaking up the product into subassemblies and understanding different assembly sequences.

Continued on p. 26

Paradigm Shifts in Manufacturing

Debra Hoitomt University of Connecticut

Two independent studies of future factories have detected a paradigm shift from mass production systems, as typified by the assembly line, to customized manufacturing, which relies heavily on automation to manufacture a high variety of items. Although the two studies were conducted in the U.S. and Japan, respectively, the conclusions drawn appear to have broad applicability. In general, a paradigm shift implies that manufacturing is moving through a period of rapid change. This article will identify the key factors motivating these changes, and explore implications for researchers and practitioners.

According to a five-year study of future factory systems performed by the Development Industry Association in Japan (Suda, 1989), mass produced items are not meeting the needs of numerous small demographic groups of consumers, which together make up sizeable market shares. These consumers provide short-term advantages to niche producers, who take profits while a trend is popular. In effect, global competi-



tion is forcing corporations to confront the weaknesses of inflexible mass production lines in order to enhance their profitability. The solution proposed in the Japanese study is to develop the manufacturing capability for responding to rapidly evolving and fragmented consumer markets.

Strikingly similar ideas are expressed in the American study conducted at the Iacocca Institute at Lehigh University (Dove & Nagel, 1991). "Agility" in manufacturing is defined, at least in part, as rapid response to new market opportunities. In identifying new markets, software systems are visualized which allow potential customers to simulate the use of virtual products and to cycle responses back into the product design. When new product concepts surface, a dynamic combination of corporations is mobilized to fill the need. Electronic communications among manufacturers and suppliers are required to realize this vision, and access to information must be improved by standardization and integration of existing heterogeneous (e.g., CAD/CAM) systems.

While critical time-to-market directives are addressed by distributed (virtual) enterprise systems, the design of products must go beyond concurrent engineering practices to incorporate product life cycle information. Highly modular component parts provide a sophisticated plugcompatible, mix-and-match approach to product construction. Improved parts or modules can then be integrated within existing products to provide almost continuous upgradeability. In this way, companies strive to develop long-term relationships with their customers as the product evolves to fit contemporary

needs and technology.

One major difference between the American and Japanese studies appears to be in the conceptualization of a production system capable of manufacturing these diverse products. The American study relies on information management structures to utilize a diverse supplier network in matching product with manufacturing process. The Japanese study focuses on the modular design of an entirely new factory system, including machines and computer integrated manufacturing (CIM) software. Similar to the product modularity concept, the autonomous elements of the future factory can be easily removed, replaced and upgraded. In addition, overlapping functionality and information is proposed in order to increase the fault tolerant behavior.

Governments are not immune to the economic impact of these studies. A major international effort in intelligent manufacturing systems (IMS) is currently underway, as initiated by the Japanese. In addition, extensive research and development efforts are also beginning in the U.S. (Advanced Research Projects Agency, Department of Defense, National Science Foundation, etc.). These funding efforts encourage consortia development and multi-disciplinary brainstorming. While some anti-trust barriers have been relaxed in the U.S. with the enactment of the National Cooperative Research Act (NCRA) of 1984, the boundaries between research and commercialization and the ownership of intellectual property are still significant concerns.

This latest step in the evolution of production systems can be viewed in an historical context. While the economies of Europe and Asia were still recovering from World War II, U.S. factories tried to maximize throughput and machine utilization, recognizing that everything produced would be sold. As worldwide competition for consumer dollars increased, the inventory reduction, quality improvement and on-time delivery associated with the Japanese kaizen concept provided a leading edge. While satisfying customers through price, delivery and quality is an old idea, the current paradigm shift can be characterized by a new emphasis on technical systems for manufacturing customized products.

Industrial potential is indeed capable of rapid and profound transformations. The industrialization of East Asia represents an object lesson: in 1965, Singapore had virtually no industrial base. The implications for the IEEE Robotics and Automation Society membership are also clear. As a professional society, our engagement with the critical issues in manufacturing systems has the potential to facilitate the transitions in machine design, CIM systems, and product development. An important barometer for measuring the function and role of our Society lies in the contribution of our work to society at large.

References

Dove, Rick and Roger Nagel (principal investigators), 21st Century Manufacturing Strategy, Bethlehem, PA: Iacocca Institute, Lehigh University, 1991.

Suda, Hiroharu, "Future Factory System Formulated in Japan," Parts 1 and 2, Techno Japan: Part 1, Vol. 22, No. 10, October 1989; Vol. 23, No. 3, March 1990.

Dan Whitney: From Robots to Design (from p.)

and permits designers to think about assembly in the small and assembly in the large at the same time.

Product design could begin with a rough layout that specifies approximate relations between parts and specifies how they will be joined. The joining relations could be specified by using library assembly features such as bearings and bearing seats, for example. It is possible to foresee setting up functional simulations by combining the inertia properties of the parts and their assembly relations, all of which would be captured when the parts were "assembled" by the designer.

Summary

In summary, I would like to reemphasize my original points. Robotics needs automation in order to remain vital and to have a reality check on its research directions. By looking at assembly, for example, researchers can formulate a wide variety of challenging problems that are often direct extensions of problems currently under study in robotics. If robotics researchers understand the constraints of the robot's environment, they can develop more robust methods and theories. If they do not, robotics applications will continue to be developed by industry, and robotics research will become inwardly directed and irrelevant. Second, automation needs robotics. There are many problems in assembly, for example, that will require robotics and computer science methods, such as 4x4 coordinate transformations, combinatorial planning, and database methods. If these and similar advanced methods are not applied, robot applications and progress will be limited to what can be achieved by the techniques of traditional engineering acting alone. Let's live up to the name of the Society: Robotics AND Automation.

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^{1.} A workshop at the 1994 San Diego Robotics and Automation Conference, exploring the implications of the manufacturing paradigm shift for society membership, is in an organizational phase.

News from Industry

Precision Robots Acquires ProgramMation

Precision Robots, Inc. today announced that it has acquired the assets of ProgramMation, Inc. (PMI), including all product lines. PRI has taken over all PMI operations and customer commitments. A worldwide supplier of monorail transport systems, PMI's manufacturing, engineering, sales and service, will be merged into PRI's Billerica, Massachusetts headquarters facility. A newly formed Transport Technology Development Group drawn from PMI's engineering staff will remain in the Philadelphia area. Mitchell Weiss, formerly President of PMI, will lead the group as Vice President of Transport Technology and will report directly to Mitch Tyson, PRI's Executive Vice President and chief Operating Officer.

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%).

(©1993 Robot Times, Newsletter of the Robotics Industries Association)

Are Things Looking Up?

Several announcements in Robotics and Automation trade publications indicate that U.S. industries are beginning to take robotics and automation seriously.

- Attendance at the International Robots and Vision Automation Show in Detroit, which has dropped off in the last few years, showed a substantial increase over 1991, with over 12,000 visitors.
- •The Automated Industries Association reported a 360% membership increase since 1991, with about 100 companies now actively participating.
- •U.S. based robotics companies reported a 21.5% increase in orders last year, although the dollar value decreased 3% from 1991.

RIA CALENDAR

- •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.
- Agile Automation Workshop Series: Flexible Parts
 Feeding for Automated Handling and Assembly.
 October 25-27, 1993. San Jose CA. Focus: How flexible parts feeding can reduce custom engineering costs, provide rapid changeover capability, extend the life of capital investments, compress system engineering time. Audience: Manufacturing professionals in food, pharmaceuticals, and electro-mechanical industries.
- •5th Annual Nat'l Robot Safety Conference. October 12-14, Novi, MI Focus: How to safeguard people working around robots
- •For more information and submission details, call Jeff Burnstein at 313-994-6088.

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Because of its modularity, the GRF-1 can be configured into a system with multiple sets of light sources and cameras to provide the 360° viewing angles necessary to measure objects in their entirety.

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Recent Ph.D. Theses in Robotics and Automation

A System for Automated Fixture Planning with Modular Fixtures

Kyoung Hung Kim: Carnegie-Mellon University, May 1993. Advisor: David Bourne. Currently: Post-doctoral Research Associate, Carnegie-Mellon University

This thesis describes a system to advance the automation of the fixture planning process with modular fixture components. Algorithms consider both physical constraints of metal cutting principles and geometric constraints. These algorithms automatically generate fixture plans with a minimal number of

machined test parts.

sequence.

In order to generate practical fixture plans, the system considers actual fixture components available in the fixture library. The system considers fixture requirements such as geometric, kinematic, and force constraints in order to automate the generation of fixture plans with little or no human assistance. Since the number of clamps in a fixture plan is often related to the cost, candidate fixture plans with a small number of clamps are first generated by placing clamps on discretized candidate clamp locations on the part. In each candidate fixture plan with known clamp locations, the algorithm checks the interference between par/fixture/cutter paths and fixtures, and estimates the minimal clamping force to hold the part rigidly. A locating plan and a supporting plan are made considering the clamping plan and locating/supporting principles. The algorithm to generate fixture plans using a vise determines various valid candidate jaws' positions and the parallel bars' heights using extensive geometric reasoning on cutter paths, the part, and the vise geometry. The necessary clamping force is estimated in consideration of the contact area between the jaw and the part.

The system has been integrated and tested with the other intelligent modules necessary for the automation of various metal cutting processes. The system typically generates multiple fixture plans for a setup within a few CPU seconds. The result shows that the system can be incorporated into a setup planning system to quickly generate a metal cutting setup

Agent Design for Automatic Use of a Software System: A Case Study with a Soar Agent for Mathematica

Dhiraj K. Pathak: Carnegie Mellon University, May 1993 Advisor: David M. Steier. Currently: Post-Doctoral Research Associate, Carnegie Mellon University

It is useful to build agents to mediate in the use of complex software systems. To understand some dimensions of mediating agents, this thesis presents an agent design for the automatic use of a computer algebra system (CAS). Such an agent must take a task specification from the user and produce a plan for achieving the task while also producing a plan for the CAS. In particular, I use the Soar architecture to build an agent forusing Mathematica, guided by a study of protocols of human users of Mathematica. The general design principles for mediating agents suggested by the particular agent for

Mathematica include a blackboard-style control structure using a production systems architecture, a dual-space planning function, integration of planning and execution, and mechanisms for automatic knowledge acquisition through environment nteraction.

Sensory Perception for an Agricultural Robot Meny Benady: Purdue University, May 1993 Advisor: Gaines E. Miles Currently: Post-doctoral Research Associate, Purdue University

A major difficulty in developing mechanized solutions for selective harvesting of easily bruised fruits, is the need to locate individual fruit and to determine whether they are sufficiently ripe. The agricultural environment is complex and loosely structured; plants vary in shape, size, color and relative location, and, the visual appearance of objects of interest is dependent on environmental influences, such as illumination, shadows or occluding leaves. One of the most important parameters which influence quality and shelf life is the ripeness of fruit at harvest. Currently, ripeness stage of fruit is determined by human pickers based on external properties which are unreliable and result in inconsistent quality. There is no sensor available today for nondestructive and rapid determination of fruit ripeness stage which could be used as a selective harvesting indicator. Furthermore, ripeness is usually defined qualitatively, since no single property of the fruit can characterize overall ripeness in a reliable manner.

This thesis develops the sensory systems for an intelligent agricultural robot to selectively harvest ripe fruit, and a mathematical model for multi-sensor fusion that is used to quantitatively define fruit ripeness. Robotic melon harvesting was undertaken as a case study to demonstrate the feasibility of the various technologies and algorithms developed in the thesis.

Fruit location is determined by using a laser range scanner to create cross-sections of field scenes. Calibration of 3-D range data includes compensation for lens distortion and noise filtering. A four-valued labeling scheme is used to interpret the scene, with each range data point being labeled as UNKNOWN, FRUIT, PLANT or GROUND. The circular Hough transform in conjunction with domain specific knowledge based rules are used for labeling the points and scene interpretation resulting in an extremely efficient and robust location technique. An enhancement to the Hough transform was developed which regards not only the number of range points supporting detection of a curve in the scene, but also the distribution of the range points on the detected object's surface. This enables location of fruit despite significant occlusion by leaves.

An electronic ripeness sniffer was developed, which is used by the robot to nondestructively measure changes in concentrations of volatile emissions by the ripening fruit. The ripeness sensor is located in an accumulator cup which is placed by the robot on the exterior of individual fruit to determine their degree of ripeness. The sensor was more sensitive to fruit ripeness than all other destructive and nondestructive

methods tested.

The sensor fusion approach developed is a general one for integration of multiple sensory inputs that are prone to inconsistencies or errors.

This approach relies on existence of a "fuzzy" classification variable that characterizes the sensory input values at a coarse numerical scale. The model was applied to the problem of defining fruit ripeness quantitatively, by integrating multiple characteristic properties of ripening fruit, using a "fuzzy" classification of the fruit into four increasingly ripe classes. A ripeness value was computed for an individual fruit based on its location relative to the ripeness class means in the multi-dimensional ripeness space. External color, flesh firmness, stem detachment force and percentage soluble sugars served as the physical indicators of melon fruit ripening. The continuous ripeness values computed serve as a criteria for the evaluation of the robot's ripeness sniffer.

An Investigation of Walker/ Terrain Interaction. Peter Nagy: Carnegie-Mellon University, August 1991. Advisors: Subhas Defa and William L. (Red) Whittaker. Currently: Asst. Prof.: Dept. Mechanical Engineering, Northern Illinois University

There will be an increased need for walking robots to locomote over unstructured terrain. Walker/terrain interaction underlies all of the stability and reliability issues associated with walking on such terrain. In this work modeling, simulation, analysis, and experiments are used to investigate and characterize this interaction in the context of reliable, autonomous walking on natural terrain.

The important effects of natural terrain that affect walker/terrain interaction are the effects of ground compliance and supports that might fail due to slope failures, slipping off the edges of rocks, etc. The interaction is characterized and controlled through nominal control, reactive control, force redistributions, and stability measures. Nominal control strategies, which are normally used to control the walker, are developed in the context of walking on natural terrain. A model for how vertical forces redistribute under a set of compliant feet due to body motion has been developed to analyze the planned motions. New stability measures that take into account the effects of compliant terrain have been developed for planning and monitoring planned

motions. Reactive control algorithms have been developed to respond to anomalous events such as support failures, unexpected foot forces, and low stability.

Walker/terrain issues that were investigated are combined to form a viable walking prescription, where the state of the walker is continuously monitored, and used to characterize the nature of the walker/terrain interaction. If the interaction is favorable, planned machine motions may be executed by using nominal control.

If the interaction is unfavorable, feet are repositioned to place the walker in a more favorable stance. It may be necessary to accept some poor footholds in order for a walker to progress; in these instances the force redistribution models may be used to ensure the stability of subsequent motions. If anomalous conditions arise that may possibly affect the stability of the walker, reactive control is employed to respond to such events. The characterization of walker/ terrain interaction and the resulting walking prescription will lead to improved ability of autonomous robots to locomote reliably on general, unstructured terrain

†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.

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J. K. Aggarwal Computer and Vision Research Center The University of Texas at Austin

A very successful 1993 IEEE Computer Society Conference on Computer Vision and Pattern Recognition was held June 15-17, 1993, at the Park Central Hotel in New York City. The conference attendance of approximately 425 persons far surpassed what had been projected. Prof. J. K. (Jake) Aggarwal (The University of Texas at Austin) served as General Chair, Dr. Ruud Bolle (IBM-T. J. Watson Research Center) and Prof. Yiannis (John) Aloimonos (University of Maryland) were Program Co-Chairs, and local arrangements were handled by Prof. Terrance Boult (Columbia University). The conference program included 89 full papers as well as 93 poster presentations covering a broad area of pattern recognition and computer vision. These papers and posters were selected from the 431 submitted papers by a Program Committee consisting of 38 members from all areas of computer vision and pattern recognition, and the two program co-chairmen.

The conference program included an invited talk on "Top Down Vision in Humans and Robots" by Professor Lawrence Stark (University of California at Berkeley and UC San Francisco Medical Center) and a panel discussion on "Computer Vision: Future Directions for Research and Funding," with panelists Drs. Oscar Firschien (ARPA), Marty Herman (NIST), and Oscar Manley (DOE), moderated by Dr. Ruzena Bajcsy (University of Pennsylvania). The 1st Siemen's Student Paper Award, consisting of a \$2,000 award and a commemorative plaque, was presented to K. Sengupta and K. L. Boyer of Ohio State University for their paper, "Information Theoretic Clustering of

Large Structure Model-bases."

In addition to the CVPR program, six half-day tutorial sessions were held in conjunction with the conference, on (1) Human and Machine Color Perception, (2) Physics Based Vision, (3) Visual Information Management Systems, (4) Object Recognition with Algebraic Geometry, Invariants, and Bayesian Methods, (5) MDL Methods in Image Analysis and Computer Vision, and (6) 3D Object Recognition Systems. Other events held in conjunction with CVPR included an IEEE Workshop on Qualitative Vision on June 14, and an IEEE Symposium on The Roles of Color in Computer Vision on June 18.

Proceedings of CVPR '93 can be obtained from the IEEE Computer Society Publications Office 10662 Los Vaqueros Circle Los Alamitos, CA 90720-1264.

The next CVPR will be held in Seattle, Washington in June 1994. Professor Kevin Bowyer, University of South Florida, is the General Chair of CVPR '94. For information about submission dates and procedures, please contact Professor Bowyer at kwb@csee.usf.edu.

Call for Papers

IEEE Transactions on Control Systems Technology

Special Issue on Automotive Control Systems

Papers are invited for a special issue of the IEEE Transactions on Control Systems Technology devoted to the subject of Automotive Control Systems, tentatively scheduled for December 1994. Papers are sought in the following general areas:

 integration of the vehicle, driver, and control systems

 control systems for electric vehicles and alternative propulsion systems

 advanced vehicle and traffic control systems

engine and exhaust gas emissions control systems

 vehicle suspension and handling control systems

vehicle guidance systems for the automated highway

 fault tolerance and safety issues in the design of automotive control systems

Contributions should focus on control systems and related topics. Survey papers are also solicited. Prospective authors of survey papers should contact one of the Guest Editors prior to submitting their contribution to confirm an interest in the proposed topic.

Submissions:

Seven copies of the complete manuscript (up to 32 double-spaced pages, including figures) should be submitted by October 15, 1993 to one of the three Guest Editors (addresses below). Manuscripts must be prepared in accordance with the standards of the IEEE Transactions on Control Systems Technology. Authors will be notified of the results of the reviews of manuscripts by March 15, 1994.

Guest Editors:

Giorgio Rizzoni: Department of Mechanical Engineering The Ohio State University 206 W. 1 8th Avenue Columbus, OH 43210-1107 tel: +1 614 292-3331 fax: +1 614 292-3163 e-mail: grizzoni@ohio-state.edu

Uwe Kiencke: Institut fur Industrielle Informationstechnik Universität Karlsruhe Hertz-Str. 16, Bau 35 Postfach 6980 D-7500 Karlsruhe Germany tel: + 49 721 608 4520 fax: + 49 721 755 788

Hideki Hashimoto: Institute of Industrial Science University of Tokyo 7-22-1 Roppongi, Minato-ku Tokyo, 106 Japan tel: +81 3 3402 6231 ext. 23sgn360 fax: +81 3 3423 1484 e -mai 1: hashimoto@ics.iis.u-tokyo.ac.jp

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.

- ·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.
- •7th IEEE Int'l Workshop on Micro/ Electro/Mechanical Systems. January 25-28, 1994. Tokyo. Submissions deadline: October 1 1993. See Announcement
- 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
- of Industrial Engineering at Rutgers University: Tel. (908) 932-3654, email:cimpro@princess.rutgers.edu.
- •1994 Int'l Conference on Data and Knowledge Systems for Manufacturing and Engineering. May 2-4 1994. Shatin, Hong Kong. Submissions: 4 copies of full (<5000wds) papers by December 3 to: (Asia/Australia) Prof. Nelson Chen, Dept of Industrial & Manufacturing Systems Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong. (America/Europe/Africa): Prof. Sudha Ram, Dept. of Management Information Systems, University of Arizona, Tucson AZ 85721 USA
- IEEE International Conference on Robotics and Automation. May 8-13, 1994. San Diego. See Announcement.



For more information contact William Townsend

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Call for Papers

Special Issue on Mobile Robots IEEE Robotics and Automation Society Magazine

This special issue focuses on the recent progress of research and development of mobile robots. The emphasis will be on creative approaches to applying mature theories and technologies of mobile robots to manufacturing and service industries, defense, and space exploration. The goal is to provide current state-of-the-art mobile robot applications to the society members and to stimulate the research and development activities in this important area. A technology assessment of the field in terms of its feasibility in practical implementation and applications is an important motivation of this special issue. The special issue will place emphasis on but not be limited to the following topics:

a. Autonomous mobile robot navigation.

b. Collision-free path planning for mobile robots.

c. Multi-sensor integration for environment understanding.

d. Legged robots negotiating difficult terrain.

e. Mobile robot dynamics, kinematics and control.

f. Coordination of manipulability and mobility. g. Neural network applications to mobile robots.

Submission of examples of innovative and successful implementation and experimentation of mobile robots are especially encouraged.

Important Dates

March 31, 1994: Deadline for paper submission.

July 31, 1994: Complete the first review cycle of all the papers and

make the preliminary selection

October 31, 1994: Complete the final review cycle of the

selected papers and make the final selection.

November 30, 1994: Final review and acceptance by Editorial

Board.

December 31, 1994: Publication of the Special Issue (the fourth issue of the magazine in 1994).

Special Issue Editors

Yuan F. Zheng
Dept. of Electrical Engineering
The Ohio State University
Columbus, OH 43210
(614) 292-2981 (Phone)
(614) 292-7596 (FAX)
zheng@ee.eng.ohio-state.edu

Xiaoping Yun
Dept. of Computer and Information
Science
University of Pennsylvania
Philadelphia, PA 19104
(215) 898-6783 (Phone)

(215) 898-0587 (FAX) yun@central.cis.upenn.edu

Instructions for Manuscripts

Five copies of each manuscript should be submitted to the Editor of the IEEE Robotics and Automation Society Magazine (not to the Special Issue Editors). Both the manuscripts and transmittal letters should be clearly marked to indicate that they are being submitted for consideration for this special issue. They will be logged and sent to the Special Issue Editors for review. Both regular and short papers will be considered. Papers must not have been published previously or submitted for publication elsewhere. (Please review the *Information for Authors for the IEEE RAS Magazine* provided in this issue of the newsletter.)

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IROS '94

IEEE/RSJ/GI International Conference

on

Intelligent Robots and Systems

- Advanced Robotic Systems and the Real World -September 12-16, 1994 — München, Germany

Today our factories are equipped with standard robotic devices performing low-intelligence jobs, but the promise of 'intdligent robots' remains largdy unfulfilled. Even large robot manufacturers are fighting for survival and are reducing their research efforts. Also, some researchers are now realizing that their contributions have not always sufficiently addressed the problems of robots operating in the real world. Apparently, the highest-priority goal of the robotic community must now be to find a real break-through in autonomy, intelligence, and dexterity for the next generation robots. Therefore, the upcoming IROS '94 conference especially asks for those contributions that show advances in robot intelligence and deterity proven by experiments or applications in the real world.

Main Topics

Intelligent Motion Control
Coordinated Control Architectures
Learning Control, Fuzzy Control
Neural Network Techniques
Advanced Sensors and Actuators
Active Sensing, Vision, Perception
Multi-sensor Integration
Sensor-based Task Planning / Execution

Environmental Modeling
Simulation and Virtual Reality
Machine Learning
Human Robot Interface and Interaction
Telerobotics
Shared Autonomy
Dexterous Manipulation
Adaptive Locomotion
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New Robotic Applications
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Deadlines

Submission of proposals for organized sessions:Dec 01, 1993Submission of papersJan 15, 1994Acceptance notificationMar 20, 1994Submission of final camera-ready paperJun 01, 1994Final acceptance notificationJun 15, 1994

Conference Organization

Advisory Council

Honorary Chair:Fumio Harashima
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Autumn is an excellents reason for visiting Bavaria and Munchen. A program of sightseeing and of cultural events is planned, especially for accompanying persons. The conference will end on the day before the opening of the famous annual beer festival Octoberfest

Addresses:

IROS '94 Secretariat München 85577 Neubiberg Germany Fax: (+49 89) 6004 3074

Regional Prog. Chair, America

Prof. Avi Kak
Purdue University
Electrical Engineering
West Lafayette
IN 47907 USA
FAX: (+1 317)494-6440

Regional Prog. Chair, Asia Prof. Shinichi Yuta

University of Tsukuba Institute of Information Science and Electronics Tsukuba 305 JAPAN

FAX (+81 298) 53 5206

Papers from America and from Asia should be sent to the respective Regional Program Co-Chairs; papers from all other areas as well as requests for additional information, should be sent to the IROS'94 Secretariat.

- •WCCI: IEEE World Conference on Computational Intelligence, June 26-July2, 1994. Orlando FL. See Announcement
- •DARS'94: Distributed Autonomous Robotics Systems. July 18-19, 1994. Saitama, Japan. Submissions: Abstract by February 28, 1994 to Dr. Hajime Asama, Chemical Engineering Lab, Institute of Physical and Chemical Research (RIKEN), Hirosawa 2-1, Wako-shi, Saitama 351-01 Japan. Tel (+81)48-462-1111 ext. 3144 Fax (+81)48-46204658.

email: asama@cel.riken.go.jp

•ASCC: 1st Asian Control Conference. July 27-30, 1994. Tokyo. Sponsors: ASCC, SICE, ISCIE. Submissions: Extended summary (1000wds) by December 15, 1993. to Prof. Kenko Uchida, Dept. of Electrical Engineering, Waseda University,

Call for Papers
CBMS'94: Computers in Medicine The 7th IEEE Symposium on
Computer-Based Medical Systems
Winston-Salem NC —June 10-11,

Device Reliability and Safety—Image Processing and Analysis—Signal Processing—Information Systems—Neural Networks and Expert Systems—Prosthetic Devices—Cardiovascular Technologies—Clinical Assessment and Risk Evaluation

CBMS will be held in conjunction with SCAR 12th Conf. for Computer Applications in Radiology

Submissions: Send 4 copies of a 2 page summary of your contribution to: (Authors west of the Mississippi, Asia and Pacific)

Nassrin Tavakoli, Info Enterprises 3260 N. Colorado St., Chandler AZ 85225-1123

(Authors east of the Mississippi and Europe)
Paul Kizakevich, Research Triangle
Institute

PO Box 12194, Research Triangle Park NC 27709

Important Dates:

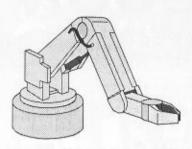
Paper Summaries: December 1, 1993 Notice of Acceptance: February 1, 1994 Camera-ready Papers: March 15, 1994

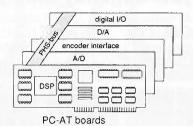
For more information: Contact Carla Muller, Department of Radiology, Bowman Gray School of Medicine, Medical Center Blvd., Winston-Salem NC USA 27157-1022, Tel: (919)716-6890 Fax: (919)716-2870); email:carla@relito.medeng.wfu.edu

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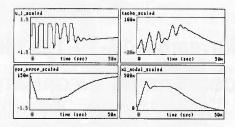




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- IROS '94: IEEE/RSJ/GI Int'l Conf. on Intelligent Robots and Systems. Theme: Advanced Robotics Systems and the Real World. SEE ANNOUNCEMENT
- SYROCO'94: IFAC Symposium on Robot Control. September 19-21, 1994. SEE ANNOUNCEMENT
- •Workshop on Neural Architectures and Distributed AI: From Schema Assemblages to Neural Networks October 19-20, 1993. Los Angeles. Submissions: A five-page extended abstract, including figures with informative captions and full references (a hard copy, either by regular mail or fax by August 15, 1993 to Michael Arbib, Center for Neural Engineering, University of Southern Califor-

- nia, Los Angeles, CA 90089-2520, USA Tel: (213) 740-9220; Fax: (213) 746-2863; email: arbib@pollux.usc.edu.
- ICARCV'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.
- FUZZ-IEEE/IFES '95: 4th IEEE Int'l Conf. on Fuzzy Systems and 2nd Fuzzy Engineering Symp.

 March 20-24, 1995. Yokohama,
 Japan. Submissions: 4 copies of full (<10pp) papers by August 31, 1994 to Congress Secretariat, LIFE (Laboratory for Int'l Fuzzy System Research, Siber Hegner Bldg 4FL, 89-1 Yamashita-cho, Naka-ku, Yokkohama 231 Japan, Att: Ms. Mieko Hemmi.



Attend IECON '93

Nineteenth Annual Conference of the IEEE Industrial Electronics Society In Technical Co-Sponsorship with the Society of Instrument and Control Engineers of Japan (SICE)

November 15-19,1993 Hyatt Regency-Maui, Lahaina, Maui, Hawaii

CONFERENCE INFORMATION

Nov 15, Monday: Registration, Tutorials

Nov 16, Tuesday: Program Sessions

Nov 17, Wednesday: Program Sessions

Nov 18, Thursday: Program Sessions Nov 19, Friday: Program Sessions, Tutorials

SPECIAL SESSION TOPICS

Power Electronics (five sessions)
Recent Trends in Process Control
Signal Processing and Control
Advanced/Intelligent Mechatronics
(two sessions)
Emerging Software Technology in
Industrial Applications

Fuzzy Control in Practice

TUTORIALS

Power Electronics and Motion Control
Multisensor Fusion & Intelligent Systems
Petri Nets and Factory Automation
Robot Vision and Autonomous Vehicles
Digital Control of AC Servo Drives &
High Performance Digital Control
Reengineering

TECHNICAL TOUR

Maui Research and Technology Center

REGULAR SESSION TOPICS

Neural Nets & Fuzzy Control Industrial Applications of Fuzzy Systems Applications in Motion Control Computer Vision Intelligent Sensors and Actuators Factory Communication and its **Applications** Control of Robot Manipulators Path Planning of Robot Manipulator Mobile Robot - Navigation and Control of Flexible Manipulators **Process Automation Power Electronics** Inverter Control Analysis and Design of Converters Applications and Algorithms in Signal Processing and Control **Optimal Control** Resonant Link Power Converters

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TRAVEL AND ACCOMMODATIONS

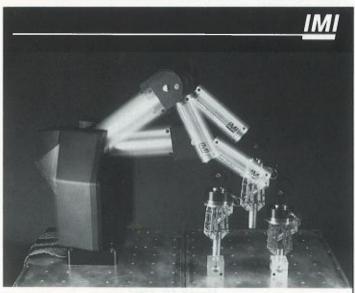
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Calendar

- August 23-26 1st (US) Nat'l Symposium on Coupling Technology to National Need. Albuquerque, NM. Contact: Roberta Hart, SPIE: Tel: (206)676-3290; FAX: (206)676-1445
- •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
- August 29-September3 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-September 3 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



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- •September 7-9 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). Amsterdam, 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 Networks Council. Contact: Meeting Management, 5665 Oberlin Drive, Suite 110, San Diego, CA 92121 Tel: 619 453 6222, fax: 619 535-3889.
- •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.surry.-ac.uk.
- *September 23-25, 1993. 2nd Int'l Robot Games. Glasgow, Scotland, UK. Contact: Dr. L. Petropulakis, (+44)41 552 6400 FAX (+44)41 552 2985
- •September 29 October 1, 1993. 31st Allerton Conference on Communication, Control And Computing. Monticello, Illinois. 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)
- •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 13-15, 1993 MHS'93: 4th Int'l symposium on Micro Machine and Human Science. Nagoya Japan. Contact: Prof. Toshio Fukuda, c/o Inter Group Corp., Sakae East BBld. 4-2-7 Sakae, Naka-ku, Nagoya 460 JAPAN. Tel +81-52-263-6261; Fax: 81 52 263 6298
- October 15, 1993. Int'l MicroRobot Maze Contest. In conj. w/ MHS'93. See Announcement
- October 17-22, 1993. 11th Int'l Symposium on Laboratory

MFI'94

CALL FOR PAPERS



IEEE International Conference on

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October 2 - 5, 1994

Las Vegas, Nevada, USA

Sponsored by: IEEE Industrial Electronics Society Society of Instrumentation and Control Engineers (SICE)

IEEE Robotics and Automation Society Robotics Society of Japan New Technology Foundation, Japan

MFI'94 is an IEEE sponsored conference devoted entirely to multisensor fusion and integration. The use of multiple sources of sensory information can increase the reliability and extend the capabilities of intelligent systems, and is currently an active area of both theoretical and applied research.

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TOPICS Papers with new research results are encouraged for submission. Topics of interest include but are not limited to:

- ♦ Algorithms for Sensor Fusion and Integration
 - Algorithms for signal-, pixel-, feature-, symbol-, and decision-level fusion
 - Representation of uncertainty
 - World model representations
 - Signal processing and probabilistic methods
 - · AI, neural networks, and fuzzy logic
 - · Knowledge engineering and databases
- Sensing Architectures
 - · Active, behavior-based, and task-directed sensing
 - Sensorimotor integration
 - Sensing system evaluation and performance modeling
 - · Placement, registration, and selection of sensors
 - · Hierarchical architectures
 - · Control of multisensor systems
 - · Fusion of active and passive sensors

- ♦ Implementation
- · Parallel and distributed processing
- · Network architectures
- Real-time processing
- · Distributed multisensor systems
- · Microsensors and integrated sensors
- · Modularization and standardization
- · Software architectures
- **Applications**
 - Target detection, tracking, and recognition
 - Mobile robot navigation
 - · Fusion-based manipulation
 - Inspection and automation
 - Virtual reality and human interfaces
 - Spatial understanding
- ♦ Other related multisensor fusion and integration topics

PAPER SUBMISSION Papers are limited to 25 double-spaced pages. Each paper should be complete with illustrations. Upon acceptance, authors will be requested to prepare a camera-ready manuscript in IEEE format (limited to 8 pages).

DEADLINES

Paper submission due:

March 10, 1994

(four copies of each complete paper to Program Co-Chair for peer review)

May 20, 1994

Acceptance notification:

July 15, 1994

Final camera-ready manuscript due:

Submit papers to either of the following Program Co-Chairs:

Masatoshi Ishikawa, Program Co-Chair Dept. of Mathematical Eng. and Information Physics Faculty of Engineering

University of Tokyo Bunkyo-ku, Tokyo 113, Japan Phone: 81-3-3812-2111 ext. 6901

Fax: 81-3-5800-6969

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Michael G. Kay, Program Co-Chair Department of Industrial Engineering Box 7906

North Carolina State University Raleigh, NC 27606, USA Phone: 919-515-2008

Fax: 919-515-5281

E-mail: kay@eos.ncsu.edu

- Automation and Robotics. Contact: James N. Little, (508)435-9500 FAX: (508)43503439
- October 25-29 IJCNN/Nagoya: Int'l Joint Conference on Neural Networks. Nagoya Japan. Contact: Shiro Usui: Secretariat, TPI, Inc., Dai-san shirakawa, Bld. 6f, 4-8-10 Meieki, Nakamura, Nagoya JAPAN. Tel 81 52 561 9889, ext 8655. Fax 81 52561 1241.
- October 22-23. 1993 IEEE/Nagoya Workshop on Learning and Adaptive Systems. Nagoya, Japan. Contact: 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.
- •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, Bunkyoku Tokyo 113 Japan. Contact: Ms. Kazuko Higuchi, Fax +81 3 3812 4628.
- •November 3-5, 1993 RO-MAN'93 Robot and Human Communication. Tokyo. Contact: Prof. Fumio Hara, Dept of Mechanical Engineering, Science University of Tokyo, 1-3 Kagurazaka, Shinjuku-ku, Tokyo 162, Japan.
- •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 8-9, 1993 IEEE/Tsukuba Int'l Workshop on Advanced Robotics. Tsukuba, Ibaraki 305 Japan. Contact: Dr. Kazuo Tani, Mechanical Engineering Laboratory, 1-2 Namiki, Tsukuba, Ibaraki 305 Japan. Tel (+81)298-58-7085 Fax(+81)298-58-7275
- •November 14-17, 1993. 1993 DND Workshop on Advanced Technologies in Knowledge Based Systems and Robotics. Contact: Chief of Research and Development (CRAD), National Defence Headquarters, Constitution Bldg., 305 Rideau St., 7th Floor, Ottawa Ontario KIA 0K@ Canada. Att: Harold Merklinger. Tel: (613)996-0761. FAX (613)996-0038.
- December 15-17, 1993 (CAMP'93) Computer Architectures
 For Machine Perception Workshop Contact: Univ. of
 Maryland, College Park, MD 20742, USA.Contact Johanna
 Weinstein by e-mail at: camp93@umiacs.emd.edu.

-1994

- February 2-4, 1994 MATH MOD Vienna: Int'l IMACS Symposium on Mathematical Modelling. Vienna, Austria. Contact: Prof. Dr. Inge Troch, Technische Universitaet Wien, Wiedner Hauptstrasse 8-10, A-1040 Wien, Austria.
- Feb. 24-25, 1994 EP'94, The Third Annual Conference on Evolutionary Programming, San Diego, CA, Sponsored by the Evolutionary Programming Society, in cooperation with the IEEE Neural Networks Council. Contact: Technical Program Chairman, Dr. Lawrence J. Fogel, ORINCON Corporation, 9363 Towne Centre Dr., San Diego, CA 92121.

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ANTENEN RESEARCH

- •March 20-23, 1994. 3rd Int'l Workshop on Advanced Motion Control. Berkeley CA. Contact: Prof. H. Kazerooni, Dept Mechanical Engineering, Univ. of Cal., Berkeley CA 94720 USA. Tel: (510) 642-2964. Fax: (510)643-5599. email:kazeroon@euler.berkeley.edu.
- •March 21-24, 1994. CIRFFSS'94: AIAA/NASA Conf. on Intelligent Robots in Field, Factory, Service and Space. Houston TX Contact: Dr. Jon D. Erickson, Lyndon B. Johnson Space Center (NASA), 2101 NASA Road 1, Houston TX 77058. Tel: (713)483-7580; Fax: (713)483-7480. email: erickson@aio.jsc.nasa.gov
- •May 2-4 1994. 1994 Int'l Conference on Data and Knowledge Systems for Manufacturing and Engineering. Shatin, Hong Kong. See Calls for Papers



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SCOPE

SY.RO.CO. '94 is the Fourth of the IFAC series of triennial Symposia on Robot Control. Previous editions were held in Barcelona (E) '85, Karlsruhe (D) '88, and Vienna (A) '91. The Symposium will cover a range of topics relevant to the field of robot control, including:

- Modelling and identification
- Control design and implementation
- Motion and force control
- Learning control and neural networks
- Sensor-based control
- Computational aspects
- Grasp control

- Multirobot systems
- Flexible manipulators
- Telemanipulation
- Autonomous robots
- Nonholonomic robotic systems
- Space robotics

CALL FOR PAPERS

Contributions describing original work are solicited on, but not limited to, the above topics. Please submit five copies of draft papers (15-20 double-spaced pages) to the Scientific Secretariat. The first page must contain the paper title, authors' names and affiliations, and complete address of the corresponding author (e-mail, fax, tel), five keywords, and the abstract (200-250 words). Each submitted paper will be sent out to competent reviewers and a recommendation will be made by the IPC on the basis of reviewers' evaluation and comments.

DEADLINES

Submission of draft papers Notification of acceptance Reception of final papers

December 15, 1993 April 15, 1994 June 15, 1994

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Only papers not published or being considered for publication elsewhere and released from all patent and proprietary restrictions may be submitted. Copyright of papers is transferred to IFAC on presentation at the Symposium.

PREPRINT VOLUME

All accepted papers will appear in the Preprint Volume. A copy of the volume will be included in the registration package of each participant to the Symposium. A number of high-quality papers will be selected by the IPC for possible publication in the IFAC journals AUTOMATICA or CONTROL ENGINEERING PRACTICE and all papers presented will be abstracted in CONTROL ENGINEERING PRACTICE.

Please contact the Technical Secretariat for all inquiries about the Symposium.

RELATED EVENTS

Overseas participants will have the opportunity to combine the trip to SY.RO.CO. '94 with two related events that will take place in Europe during the preceding week:

- 10th CISM IFToMM Symposium on Theory of Robots and Manipulators (Ro.Man.Sy. '94), Gdańsk, Poland, Sept. 12-15, 1994.
- 1994 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 94), Munich, Germany, Sept. 12-16, 1994.

VENUE

The island of Capri is the jewel of the Bay of Naples. It is renowned for its Blue Grotto, Faraglioni rocks, variety of Mediterranean flora and fauna, and the beauty of its scenery. The environment constitutes the ideal venue for stimulation and interchange of ideas among scientists. Capri is 17 miles far from Naples and can be reached by either hydrofoil or ferry-boat. Naples can be reached by plane from major European cities and from Rome and Milan, as well as by train in a two-hour journey from Rome.

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Huntsville, AL 35824-6402
Phone: (205) 461-3413
e-mail: byron@hsvaic.boeing.com

Parallel/Distributed Robot Computing Systems Amir Fijany, JPL Lab, Cal. Inst. Tech MS 303-310 4800 Oak Grove Drive Pasadena, CA 91109 Phone: (818) 354-9552

Sensor Integration and Fusion Ren Luo, North Carolina State Univ. Department of Electrical and Computer Engineering Box 7911 Raleigh, NC 27695-7911 Phone: (919) 737-5199,-5193 Fax: (919) 737-7382

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- ·May 8-13, 1994. IEEE Int'l Conference on Robotics and Automation San Diego. See Announcement
- •July 18-19, 1994. DARS'94: Distributed Autonomous Robotics Systems. Riken, Saitama, Japan. See Calls for Papers
- •July 27-30, 1994. ASCC: 1st Asian Control Conference. Tokyo. See Calls for Papers
- •September 12-16 1994. IROS '94: IEEE/RSJ/GI Int'l Conf.on Intelligent Robots and Systems. Munich See Announcement
- September 19-21 1994 SYROCO'94: IFAC Symposium on Robot Control. See Announcement
- •November 8-11, 1994. ICAR'94: 3rd Int'l Conference on Automation, Robotics and Computer Vision. See Calls for Papers

·1995

 March 20-24, 1995. FUZZ-IEEE/ IFES '95: 4th IEEE Int'l Conf. on Fuzzy Systems and 2nd Fuzzy Engineering Symp. Yokohama, Japan. See Calls for Papers

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 cholarly 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.

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Assembly and Task Planning Damian M. Lyons, Philips Labs Autonomous Systems Dept. 345 Scarborough Road Briarcliff Manor, NY 10510 Phone: (914) 945-6444 e-mail: dml@philabs.philips.com Manufacturing System Integration and Applications F. Nicolo, Universita di Roma "La

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Russell H. Taylor, IBM T.J. Watson Res. Ctr P. 0. Box 704 Yorktown Heights, NY 10598 Phone: (914) 784-7796; Fax: (914) 784-6282 e-mail: rht@watson.ibm.com

Discrete Event Dynamic Systems Tarek M. Sobh Dept of Computer Science University of Utah 3190 Merrill Engineering Bldg. Salt Lake City Utah 84112 Phone (801)265 8257; Fax 581 5343 email sobh@cs.utah.edu

Kimon P. Valavanis Center for Advanced Computer Studies University of Southwestern Louisiana Lafayette LA 70504 4330 Phone 318 231 5779; 318 231 6284 (sect'y) FAX 318 231 5791; email kimon@cacs.usl.edu

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May 8-13, 1994 Princess Resort San Diego, California

CALL FOR PAPERS

The theme of the 1994 Conference is "Robotics and Automation in the Service of Humankind." This year, the Conference celebrates its 11th anniversary. Major scientific and engineering accomplishments have been reported over the last decade. As the field matures, the research community now is 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 and quality control 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. Technical papers presented on Tuesday, Wednesday, and Thursday, May 10-12, will appear in the bound proceedings. Topics include but are not limited to:

- Robot sensing and sensor data fusion
- · Reasoning and planning
- Multirobot coordination
- · Dexterous and redundant manipulation
- · Robot dynamics and control
- · Telerobotics and shared control
- Autonomous systems
- · Micro electromechanical and micro robotic systems
- · Advanced actuators
- Mechatronic design issues

PAPER SUBMISSION

Six copies of each paper should be sent by October 1, 1993, to:

Harry E. Stephanou

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Papers should be submitted in final format with a 2-column format on 8.5" x 11" sheets. Each column is limited to 3 1/4" x 8 7/8" with a 3/8" gutter between columns. The margins are 13/16" on the sides, 1 1/16" on the top and bottom. Text is to be typed single spaced in 10-point Times Roman (or a font closely resembling this type), with 12-point interline spacing. The first page of the paper, centered on the top below the top margin, should include the paper title, the authors' names, and their affiliations. Six pages are allowed for each paper. Up to two additional pages will be permitted for a charge of \$150 for each additional page. Illustrations are included in the page count. A separate sheet of paper should be provided including the following information: (1) The name, fax number and email address of the corresponding author; (2) the abstract of the paper; (3) a brief paragraph summarizing the contributions of the paper and its potential applications.

Authors will be notified about the disposition of their papers by January 14, 1994. Final papers reflecting any minor changes recommended by the reviewers, will be due by February 15, 1994.

· Distributed intelligence and self-organizing systems

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THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, IN

ROBOTICS AND AUTOMATION

Sponsored by the IEEE Robotics and Automation Society

INVITED SESSIONS

Invited sessions are intended to provide a cohesive focus for the introduction of new research topics, or for the discussion of successful applications and case studies. Proposals for invited sessions should be submitted by October 1, 1993 to the Program Chair. Each invited session consists of four papers, which will be reviewed through the normal process. The proposal should be submitted by the session organizer, and include a brief statement of purpose in addition to six copies of each paper. In case an invited paper is not accepted, it will be replaced by a relevant contributed paper.

PANEL DISCUSSIONS:

Panel discussions are intended to promote an active and informal discussion of current issues that are of interest to the Robotics and Automation community. Proposals should include a brief statement of purpose, the general topic of discussion, specific issues to be addressed, and a list of participants. They should be sent to the Program Chair no later than October 1, 1993.

TUTORIALS AND WORKSHOPS:

Half day and full day tutorials and workshops will be held on Sunday, May 8; Monday, May 9; and Friday, May 13, 1994. Proposals should include: (1) statement of objectives and background expected of intended audience, (2) a complete list of speakers and their affiliations, (3) a detailed list of topics. Two copies of each proposal should be submitted by October 1, 1993 to:

Pradeep Khosla

Department of Electrical and Computer Engineering Carnegie Mellon University Pittsburgh, PA 15213-3890, U.S.A. Telephone: 412-268-5090

Fax: 412-268-3890 Email: pkk@cs.cmu.edu

Organizers are strongly encouraged to write or send email to the above address to obtain the exact proposal format. Proposals not in the proper format may not be evaluated.

ANTON PHILIPS BEST STUDENT PAPER AWARD:

A \$1,000 prize will be awarded for the best student paper. The student must (1) be a member of the IEEE Robotics and Automation Society, (2) be the first author and primary developer of the ideas, and (3) have done the work as part of an academic degree program. The paper must be submitted no later than one year after the award of the degree for which the work was done. Nine copies of the paper along with a nominating letter from the faculty advisor should be sent by October 1, 1993 to the Program Chair.

DEVELOPING COUNTRIES FELLOWSHIPS:

Travel assistance of up to \$500 and a waiver of the registration fees will be granted to a limited number of selected applicants from developing countries. Preference will be given to university students. Applications should include: (1) the name, postal address, telephone and fax numbers, and email address (if applicable), (2) professional affiliation, position, and nature of work, and (3) a brief statement about how attendance at the conference will enhance the applicant's career. May 8-13, 1994 Princess Resort San Diego, California

Applications should be submitted by October 1, 1993 to:

George Bekey

Computer Science Department University of Southern California Los Angeles, CA 90089-0782, U.S.A. Fax: 213-740-7285

Email: bekey@pollux.usc.edu

BEST CONFERENCE PAPER AWARD:

A \$1,000 prize will be awarded to the best conference paper.

EXHIBITS:

There will be exhibits of state-of-the-art hardware and software products at the conference. Reservations for space and further information may be obtained from:

Scott Harmon

Hughes Research Laboratories 3011 Malibu Canyon Road M/S RL 96 Malibu, CA 90265, U.S.A. Telephone: 310-317-5140 Fax: 310-317-5695

Email: harmon@aic.hrl.hac.com

LOCAL ARRANGEMENTS:

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. It is serviced by 16 major airlines with direct flights to many international cities. San Diego is a center for high technology, R&D, 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 best climate in the United States, San Diego is known for its universities, research laboratories and industries, as well as fine restaurants and hotels. 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. Additional information may be obtained from:

Marko Vuskovic

Department of Mathematical Sciences San Diego State University San Diego, CA 92182-0314 Telephone: 619-594-4302 Fax: 619-535-8054

Email: marko@saturn.sdsu.edu

GENERAL INFORMATION:

For general information about the conference, contact the General Chair:

William A. Gruver School of Engineering Science Simon Fraser University Burnaby, B.C., Canada V5A 1S6 Telephone: 604-291-4371

Fax: 604-291-4951 Email: gruver@sfu.ca

IEEE Robotics and Automation Society LOGO DESIGN CONTEST Update





? R&A

We have received entries from 19 R&A artist/members from Australia, Canada, England, India, Italy, Malaysia, Scotland, Northern Ireland, and Yugoslavia. The winner will be announced and the winning logo unveiled in the inaugural issue of the Robotics and Automation Society magazine.

IEEE Robotics & Automation Society



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