



Seventh International Symposium on *Experimental Robotics*

December 10-13
Honolulu, Hawaii

Princess Kaiulani Hotel, Waikiki

Final Program

Program Committee

- ◆ Alicia Casals, Spain
- ◆ Raja Chatila, France
- ◆ Peter Corke, Australia
- ◆ Eve Coste-Maniere, France
- ◆ John Craig, U.S.A.
- ◆ Paolo Dario, Italy
- ◆ Vincent Hayward, Canada
- ◆ Gerd Hirzinger, Germany
- ◆ Oussama Khatib, U.S.A.
- ◆ Jean-Pierre Merlet, France
- ◆ Yoshihiko Nakamura, Japan
- ◆ Daniela Rus, U.S.A.
- ◆ Kenneth Salisbury, U.S.A.
- ◆ Herman Bruyninckx, Belgium
- ◆ Sanjiv Singh, U.S.A.
- ◆ James Trevelyan, Australia
- ◆ Tsuneo Yoshikawa, Japan
- ◆ Alex Zelinsky, Australia

Organizing Committee

- ◆ Conference Co-Chair: Daniela Rus, Dartmouth University U.S.A.
- ◆ Conference Co- Chair: Sanjiv Singh, Carnegie Mellon University, U.S.A.
- ◆ Local Arrangements: Song Choi, University of Hawaii, U.S.A
- ◆ Registration: Dot Marsh, Carnegie Mellon University

Sponsorship

- ◆ Dartmouth University
- ◆ Carnegie Mellon University

Schedule At A Glance

Sunday, Dec,10

7:30 - 8:00pm	Registration Open	Poolside
8:00 - 10:00pm	Reception	Poolside

Monday, Dec 11

8:00 – 9:00	Continental Breakfast/Registration	11 th Floor Meeting Room
8:45 – 9:00	Opening Remarks	11 th Floor Meeting Room
9:00 – 10:00	Invited Talk: Russ Taylor, <i>The Future of Medical Robots in Computer-Integrated Surgery</i>	11 th Floor Meeting Room
10:00 – 10:30	Break	11 th Floor Lobby
10:30 – 12:15	M I: Humanoids & Human-Robot Interaction	11 th Floor Meeting Room
12:15 – 1:30	Lunch	On your own
1:30 – 3:00	M II: Perception	11 th Floor Meeting Room
3:00 – 3:30	Break	11 th Floor Lobby
3:30 – 5:00	M III: Assembly and Manipulation	11 th Floor Meeting Room

Tuesday, Dec 12

8:30 – 9:00	Continental Breakfast	11 th Floor Meeting Room
9:00 – 10:30	T I: Medical, Space, and Field Applications	11 th Floor Meeting Room
10:30 – 11:00	Break	11 th Floor Lobby
11:00 – 12:30	T-II: Locomotion	11 th Floor Meeting Room
12:30 – 2:00	Lunch	On your own
2:00 – 3:00	Invited Talk, Hirochika Inoue, <i>Experimental Studies on Humans and Humanoids</i>	11 th Floor Meeting Room
3:00 – 3:30	Break	11 th Floor Lobby
3:30 – 5:00	T-III: Multi-Robot Systems	11 th Floor Kaiulani
7:00 – 8:00	Cocktails	Daimond Lawn
8:00 – 10:00	Banquet	Daimond Lawn

Wednesday, Dec 13

8:30 – 9:00	Continental Breakfast	11 th Floor Meeting Room
9:00 – 10:30	W-I: Modelling and Motion Planning	11 th Floor Meeting Room
10:30 – 11:00	Break	11 th Floor Lobby
11:00 – 12:30	W-II: Control	11 th Floor Meeting Room
12:30 – 2:00	Invited Talk: Vladimir Lumelsky, Information technology and intelligent sensing at NSF	11 th Floor Meeting Room Brown bag lunch provided
2:00 – 3:00	Invited Talk, Gerd Hirzinger & Ralf Koeppel, <i>A New Generation of Light-weight Robot Arms and Multifingered Hands</i>	11 th Floor Meeting Room
3:00 – 3:30	Break	11 th Floor Lobby
3:30 – 5:00	W-III: Navigation and Localization	11 th Floor Meeting room
5:30 – 7:00	Fairwell Reception	Poolside

Detailed Schedule

Sunday, Dec 10, 2000

7:30 pm Registration Open (Poolside)

8:00 pm Reception (Poolside)

Monday, Dec 11, 2000

8:00 am Registration Open/ Continental Breakfast

8:45 Opening Remarks

9:00 **Invited Talk: Russ Taylor, Johns Hopkins University**
The Future of Medical Robots in Computer-Integrated Surgery

10:00 Break

10:30 **Session M-I: Humanoids and Human-Robot Interaction**
Chairs: A. Casals and O. Khatib

Haptically Augmented Teleoperation

Nicolas Turro, Oussama Khatib, Stanford University, & Eve Coste-Maniere

Bilateral teleoperation for further distance and finer operation

Y. Yokokoji, I. Imaida, Y. Ida, T. Doi, M. Oda, and T Yoshikawa

Virtual Exoskeleton

J. Amat, M. Frigola, and A. Casals,

Design of Programmable Passive Compliance (PPC) Mechanism using Closed Kinematic Chain--PPC Cybernetic Shoulder for Humanoid Robots,

Masafumi Okada, Yoshihiko Nakamura, and Shigeki Ban

Design and Implementation of Humanoid H6

S. Kagami, K. Nishiwaki, J. Kuffner, T. Sugiuhara, M. Inaba, and H. Inoue

Combined Human and Machine Perception in Teleoperated Assembly,

T. Debus, P. Dupont, and R. Howe

Regulation and Entrainment in Human Robot Interactions

Cynthia Breazeal

12:15 Lunch on your own

1:30 Session M-II : Perception
Chair: D. Pai

Advancing Active Vision Systems by Improved Design and Control
Alexander Zelinsky

S-Nets: Smart Sensor Networks
Tom Henderson and Yu Chen

Six Degree of Freedom Position Ranging using IR LED Emitters and Receivers
Kimon Roufas, Ying Zhang, Dave Duff, and Mark Yim

Height Estimation for an Autonomous Helicopter
Peter Corke, Pavan Sikka, and Jonathan Roberts

Ladar-based Discrimination of Grass from Obstacles for Autonomous Navigation
J. Macedo, R. Manduchi and L. Matthies

Reality-Based Modeling with ACME: a Progress Report,
D. K. Pai, J. E. Lloyd, and J. L. Richmond

3:00 Break

3:30 Session M-III : Assembly and Manipulation
Chairs: M. Kaneko and P. Dario

Grasp Strategy Simplified by DAM
M. Kaneko, T. Shirai, K. Harado, and T. Tsuji

Force-based Interaction for Distributed Precision Assembly
. DeLuca, A. Rizzi, and R. Hollis

A New Spatial Binary-Actuated Manipulator Design
J. Suthakorn and G. Chrikijian

Design and Experiments on a Novel Biomechatronic Hand
M. C. Carroza, P. Dario, B. Massa, M. Zecca, and S.Micera

Autonomous Injection of Biological Cells Using Visual Servoing
Sun Yu and Bradley Nelson

Design and Control of a Novel Robotic End-Effector for Grabbing and Holding Sacks and Bags
H. Kazerooni and C. Foley

Tuesday, Dec 12, 2000

8:30 am Continental Breakfast

9:00 Session T-I: Medical, Space, and Field Applications
Session Chairs: E. Coste-Maniere and S. Dubowky

An Active Tubular Polyarticulated Microsystem for Flexible Endoscope
Szewczyk, deSars, Bidaud, and Dumont

Towards Semi-Autonomy in Laparoscopic Surgical Robotics using Visual Servoing
A. Krupa, C. Doignon, G. Gangloff, M. de Mathelin, and G. Morel

Optimized Port Placement for the Totally Endoscopic Coronary Artery Bypass Grafting using the da Vinci Robotic System
Eve Coste-Maniere, L. Adhami, R. Severac-Bastide, K. Salisbury, J. D. Boissonat, N. Swarup, G. Guthard, E. Mousseau, D. Blanchard, and A. Carpentier

ETS VII Flight Experiments for Space Robot Dynamics and Control: the theories in laboratory ten years ago, now in orbit
Kazuya Yoshida

Experimental Demonstrations for a New Paradigm in Space Robotics
M. D. Lichter, V. A. Sujan, and S. Dubowsky

A First Experiment of Long Term Activity of Autonomous Mobile Robot--Result of Repetitive Base-Docking over a Week
Yashushi Hada and Shin'ichi Yuta

10:30 Break

11:00 Session T-II: Locomotion
Session Chairs: S. Hirose and D. Rus

What is "Biomimetic" Robot Locomotion?
Sean A. Bailey, J. Cham, R. Full, and M. Cutkosky

Super Mechano-System: New Perspective for Versatile Robotic System
Shigeo Hirose

Using Modular reconfigurable robots for locomotion
D. Rus

Open-Loop Verification of Motion Planning for an Underwater Eel-Like Robot
Kenneth A. McIsaac and James P. Ostrowski

Quadruped Robot Running with a Bounding Gait

S. Talebi, M. Buehler, and E. Papadopoulos

Evidence for Spring Loaded Inverted Pendulum Running in a Hexapod Robot,

H. Komsuoglu, I. Scher, R. Full, U. Saranly, M. Buehler, B. Brown, N. Moore, & D. Koditschek

12:30 Lunch (on your own)

2:00 **Invited Talk: Hirochika Inoue, The University of Tokyo**
Experimental Studies on Humans and Humanoids

3:00 **Break**

3:30 **Session T-III: Multi-robot Systems**
Session Chairs: V. Kumar and K. Kosuge

A Framework and Architecture for Multirobot Coordination

R. Alur, A. Das, J. Esposito, R. Fierro, C. Gudic, Y. Hur, V. Kumar, I. Lee, J. Ostrowski, G. Pappas, B. Southall, J. Spletzer, and C. J. Taylor

Motion Control of Distributed Robot Helpers Transporting a Single Object in Cooperation with a Human

Y. Hirata and K. Kosuge

Coordination of Heterogeneous Robots for Large-Scale Assembly

R. Simmons, S. Singh, D. Hershberger, J. Ramos, and T. Smith

Toward a Team of Robots with Repair Capabilities: Docking Systems

C. Bereton and P. Khosla

Merging Gaussian Distributions for Object Localization in Multi-Robot Systems

A. W. Stroupe, M. C. Martin, and T. Balch

Principled Communication for Dynamic Multi-Robot Task Allocation

B.P. Gerkey and M. Mataric

Progress in Robot World Cup Soccer (Robocup) Research Issues in 2000

M. Asada, A. Birk, E. Pagello, M. Fujita, I. Noda, S. Tadokoro, D. Duhaut, P. Stone, M. Veloso, T. Balch, H. Kitano, and B. Thomas

7:00 **Cocktails (Banquet Lawn)**

8:00 **Banquet (Diamond Lawn)**

Wednesday, Dec 13, 2000

8:30 am Continental Breakfast

9:00 Session W-I: Modelling and Motion Planning
Session Chairs: A. Rizzi and J-C. Latombe

Sensor Based Motion Planning and Exploration for Eye-in-Hand Systems in Unknown Environments

Yong Yu and Kamal K. Gupta

Motion Planning of Self-Reconfigurable Modular Robot

Eiichi Yoshida, S. Murata, A. Kaminura, K. Tomita, H. Korokawa, and S. Kokaji

Experimental Comparison of Techniques for Localization and Mapping using a Bearings Only Sensor

M. Deans and M. Herbert

Robot Navigation for Automatic Construction using Safe Regions

Hector Gonzalez Banos and Jean-Claude Latombe

Simulation and Experimental Evaluation of Complete Sensor-based Coverage in Rectilinear Environments

Zack J. Butler, A. Rizzi, and R. Hollis

An Interactive Model of the Human Liver

F. Boux de Casson, D. D'aulignac, and C. Laugier

10:30 Break

11:00 Session W-II: Control
Session Chairs: S. Singh and J. Hollerbach

The Biomechanical Fidelity of Slope Simulation on the Sarcos Treadport using Whole-Body Force Feedback

Rose Mills, John Hollerbach, and William Thompson

A New Approach to the Control of a Hydraulic Stewart Platform

M. R. Sirouspour and S. E. Salcudean

Evaluation of Brake-Actuated Haptic Robots

Y. Matsuoka and W. Townsend

Micro Nafion Actuators for Cellular Motion Control and Underwater Actuation

W. Li, M. Kwok, and Y. Xu

Control of an Underactuated Unstable Nonlinear Object

Nils A. Andersen, L. Skovgaard, and O. Ravn

Singularity Handling on Puma In Operational Space Formulation

Denny Oetomo, Marcelo H. Ang Jr., and Lim Ser Long

12:30 **Invited Talk: Vladimir Lumelsky, National Science Foundation**
Information technology and intelligent sensing at NSF

2:00 **Invited Talk: Gerd Hirzinger, The University of Tokyo**
A New Generation of Light-weight Robot Arms and Multifingered Hands

3:00 **Break**

3:30 **Session W-III: Navigation and Localization**
Session Chairs: R. Chatila and Steve Scheding

Autonomous Rover Navigation on Unknown Terrains: Demonstrations in the Space Museum "Cite de l' Espace" at Toulouse

Simon Lacroix, Anthony Mallet, David Bonnafoous, Sara Fleury, Matthieu Herrb, and Raja Chatila

Map Building and Location for Underwater Navigation

S. Majumder, J. Rosenblatt, S. Scheding, and H. Durrant- Whyte

Visually Realistic Mapping of a Planar Environment with Stereo

L. Iocchi, K. Konolige, and M. Bajracharya

Incorporation of Delayed Decision Making into Stochastic Mapping

J. Leonard and M. Rikoski

Tele-Autonomous Watercraft Navigation

Ray Jarvis

The Development of an Underwater Vehicle Monitoring System and Its Sensor Systems

S. Choi and O. T. Easterday

Real time obstacle detection for AGV Navigation using Multi-base Stereo

H. Wang, J. Xu, J. Guzman, R. Jarvis, T. Goh, and C. Chan

5:30 **Farewell Reception (Poolside)**

Invited Speakers

Russell Taylor, Director of the NSF Engineering Research Center for Computer-Integrated Surgical Systems and Technology, Johns Hopkins University, USA

The Future of Medical Robots in Computer-Integrated Surgery

The impact of Computer-Integrated Surgery (CIS) on medicine in the next 20 years will be as great as that of Computer-Integrated Manufacturing on industrial production over the past 20 years. A novel partnership between human surgeons and machines, made possible by advances in computing and engineering technology, will overcome many of the limitations of traditional surgery. By extending human surgeons' ability to plan and carry out surgical interventions more accurately and less invasively, CIS systems will address a vital national need to greatly reduce costs, improve clinical outcomes, and improve the efficiency of health care delivery. As CIS systems evolve, we expect to see the emergence of two dominant and complementary paradigms: Surgical CAD/CAM systems will integrate accurate patient-specific models, surgical plan optimization, and a variety of execution environments permitting the plans to be carried out accurately, safely, and with minimal invasiveness. Surgical Assistant systems will work cooperatively with human surgeons in carrying out precise and minimally invasive surgical procedures. This presentation will focus on the emerging role of medical robots within CIS systems, with special attention to the synergy between the development of image-guided, robotically-assisted delivery systems and the development of novel minimally invasive localized therapies. It will draw upon current and ongoing research in the newly established NSF Engineering Research Center for Computer-Integrated Surgical Systems and Technology and elsewhere to illustrate these themes.

Hirochika Inoue, Department of Mechano-Informatics, The University of Tokyo, JAPAN

Experimental Studies on Humans and Humanoids

This talk attempts to discuss where experimental robotics shall go in the new century. For a long time, robots have been considered "objects to be created". After four decades of robotics research, we are reaching a new stage of robotics R&D. Companies are going to provide various robots to the end-user market. The Humanoid Robotics Project of Japan intends to develop and provide a platform for humanoid R&D. Now, robots are not only objects to be built, but also tools to be used for studying humans and robots. We can view a humanoid as a human-shaped robot, but also, we can recognize the humanoid as novel computing machinery, which can not only compute, but also behave. We are obtaining a powerful new tool for the experimental study of humans and humanoids.

This talk consists of four parts, taking examples from our research at the University of Tokyo. In Part One, four key technologies of robotics will be introduced: (1) sensor-implanted soft tactile skin, (2) robots with spine as an example of soft mechanical structure, (3) real-time 3D robot vision systems and (4) simulation and motion planning of robots and environments. Part Two deals with system integration. First, the remote-brained approach to robotics is introduced with some experimental examples. Then, the study of humanoid robots at our laboratory will be introduced: H3, an upper-body humanoid mounted on a wheeled base, designed to be controlled remotely over a network; H5, a prototype human-shaped robot, designed for the study of dynamic walk; and H6, a humanoid platform for integrating various functions of softness and intelligence. In Part Three, the HRP project, a Japanese national project for R&D of humanoid and human-friendly robotics will be introduced. The project attempts a platform-based R&D for seeking applications of humanoid robots in practical settings. And lastly, in Part Four, I will discuss some topics for robotics research in the coming century. At a time when we are entering into a new millennium, we are standing on a new robotics setting. From there, three ways seem to be open: (1) advanced R&D of robotics core technologies, (2) real applications for human-centered robotized society, and (3) synthetic study of human behavior science.

Gerd Hirzinger & Ralf Koeppel, Institute of Robotics and Mechatronics, German Aerospace Center (DLR), GERMANY

A New Generation of Light-weight Robot Arms and Multifingered Hands

The talk describes recent design and development efforts in DLR's robotics lab towards a new generation of ultra-light weight robots with articulated hands. The design of fully sensorized joints with complete state feedback and the underlying mechanisms are outlined. The second joint torque-controlled light-weight arm generation is available now, as well as the second generation of a highly integrated 4 finger-hand implying 13 actuators and more than 100 sensors. Thus we hope that important steps towards a new generation of service and personal robots have been achieved, with space robotics becoming a major driver due to the need for advanced "robonaut" technologies.

Vladimir Lumelsky, Program Director, Robotics and Human Augmentation, National Science Foundation

Information technology and intelligent sensing at NSF

