

# IROS 2011

2011 IEEE/RSJ International Conference on  
Intelligent Robots and Systems

September 25-30, 2011  
San Francisco, California

Events Guide



Room	Golden Gate	Continental 1	Continental 2	Continental 3	Continental 4	Continental 5	Continental 6	Continental 7	Continental 8	Continental 9
14:00-15:30		Microsensing	Localization	Audition	Telerobotics	Bio-inspired	Field robotics	Wheeled robots	Learning policies	Novel actuators
15:30-16:00					Coffee break					
16:00-17:30	Interactive I	Micromanipulation	Localization	Audition	Demonstrations	Bio-inspired	Field robotics	Teleoperation	Learning for control	Novel actuators
17:30-18:30					Break					
18:30-20:00					Welcome reception, Continental Ballroom					

## Tuesday, September 27

8:00-9:30	Interactive II	Object recognition	SLAM	Microrobotics	Platforms Forum	Medical robotics	Grasping	Software	Bio-inspired	Exploration
9:30-10:00					Coffee break					
10:00-11:30	Interactive III	Perception	SLAM	Microrobotics	Generation Forum	Medical robotics	Grasping	Contact deformation	Limbed robots	Learning
11:30-12:30					Lunch break					
12:30-13:45				Design Plenary: Shigeo Hirose, Gerd Hirzinger, and Marc Haibert. Chair: Bernie Roth						
13:45-14:00					Coffee break					
14:00-15:30	Interactive IV	Collision avoidance	Motion estimation	Microrobotics	Horizon Forum	Medical robotics	Grasping	Actuator design	Fish-inspired	Novel sensors
15:30-16:00					Break					
16:00-22:00				Dinner cruise on the San Francisco Bay *						

## Wednesday, September 28

8:00-9:30	Interactive V	HRI	Representation	Medical robotics	Haptics	Motion planning	Aerial robotics	Walking	Networked robots	Vision
9:30-10:00					Coffee break					
10:00-11:30	Interactive VI	Assistive robots	Estimation and fusion	Surgical robotics	Haptics	Motion planning	Aerial robotics	Passive walking	Multirobot systems	Visual servoing
11:30-12:30					Lunch break					
12:30-13:45				BioRobotics Plenary: Alain Berthoz, Heinrich Bülthoff, Mandyam Srinivasan. Chair: Ruzena Bajcsy						
13:45-14:00					Coffee break					
14:00-15:30	Interactive VII	HRI	Visual tracking	Safety	Haptics	Motion planning	Marine robotics	Humanoid control	Multirobot planning	Sensor calibration
15:30-16:00					Coffee break					
16:00-17:30	Interactive VIII	HRI	Motion prediction	Haptic rendering	Medical Rob. Forum	Motion planning	Marine robotics	Gait analysis	Modular robots	Identification
17:30-18:30					Break					
18:30-23:00				Evening at the Museum with Picasso **						

## Thursday, September 29

8:00-9:30	Interactive IX	Force control	RGB-D	Kinodynamic plan.	Stochasticity	Biped locomotion	Robot vision	Joint design	Autonomous vehicles	Anthropomorphic R.
9:30-10:00					Coffee break					
10:00-11:30	Interactive X	Grasping control	Mapping	Randomized plan.	Stochasticity	Humanoids	Robot vision	Medical robots	Rescue robots	Transportation
11:30-12:30					Lunch break					
12:30-13:30				Awards Ceremony						
13:30-14:30				Self-driving Cars Plenary: Sebastian Thrun and Chris Urmson. Chair: Henrik Christensen						
14:30-14:45					Break					
14:45-16:15	Interactive XI	Manipulation	Industrial robots	Marine systems	(Self-)assembly	Humanoids	Robot vision	Exoskeleton robots	Aerial robots	Swarms and flocks
16:15-16:45					Coffee break					
16:45-17:45	Interactive XII	Climbing	Novel locomotion	Marine systems	Town Hall Meeting on Conferences.	Moderator: Peter Corke		Medical robots	Aerial robots	Novel designs
17:45-18:30					Break					
18:30-20:00				Farewell reception, Continental Ballroom						

\* Dinner Cruise: Buses will be leaving at 16h00 from the Taylor Street entrance.

\*\* Evening at the Museum: Buses will be leaving at 18h30 from the Taylor Street entrance.

# IROS 2011 Forums

IROS 2011 features five forums, each one session long. Each forum includes representatives from robotics companies, governmental institutions, and universities making short presentations and engaging in a moderated panel discussion among themselves and with the audience.

## **Robots: The New Commercial Platforms**

**Moderator: Rüdiger Dillmann, Karlsruhe Institute of Technology, Germany**  
**Tuesday, September 27, 2011, 8:00-9:30, Continental Ballroom 4**

This forum focuses on recent and emerging robotic platforms. Participants from industry discuss recent and projected advances in robotic technology with a commentary on emerging applications.

**Speakers:** Aaron Edsinger, Meka Robotics, California  
Bernd Liepert, KUKA Laboratories, Germany  
Bruno Maisonnier, Aldabaran Robotics, France  
Roko Tschakarow, Schunk, Germany  
Thomas Fuhbrigge, ABB Research, Windsor, Connecticut

## **Robots: The Next Generation**

**Moderator: Steve Cousins, Willow Garage, California**  
**Tuesday, September 27, 2011, 10:00-11:30, Continental Ballroom 4**

This forum focuses on next generation robotic platforms, new business models for robotics, and the role of open software. Participants from industry discuss advances in robotic technology with an emphasis on software and applications.

**Speakers:** Jan Becker, Bosch Research, California  
Yoshiaki Sakagami, Honda Research Institute USA, California  
Chris Urmson, Google, California, California  
Regis Vincent, SRI International, California

## **Robotics: Beyond the Horizon**

**Moderator: Hirochika Inoue, University of Tokyo, Japan**  
**Tuesday, September 27, 2011, 14:00-15:30, Continental Ballroom 4**

In addition to the industrial forums, IROS 2011 features a special 'Blue Sky' forum on the future of robotics. Participants from academia, government, and industry present their visions for the future of the field.

**Speakers:** Robert O. Ambrose, NASA, Texas  
Henrik Christensen, Georgia Tech, Georgia  
Paolo Dario, Scuola Superiore Sant'Anna, Pisa, Italy  
Juha Heikkilä, European Commission  
Hirohisa Hirukawa, AIST, Japan  
James Kuffner, Google, California  
Yoshihiko Nakamura, University of Tokyo, Japan

## **Medical Robotics**

**Moderator: Paolo Dario, Scuola Superiore Sant'Anna, Pisa, Italy**  
**Wednesday, September 28, 2011, 16:00-17:30, Continental Ballroom 4**

This forum focuses on the rapidly growing field of medical robotics. In synergy with the Symposia on medical robotics at IROS 2011, this forum features industry experts discussing and presenting cutting edge commercial advances in the field.

**Speakers:** Hyosig Kang, MAKO Surgical, Florida  
Ralf Koeppel, KUKA Laboratories, Germany  
Jean Chang, Hansen Medical, California  
Gary S. Guthart, Intuitive Surgical, California

## **On Robotics Conferences: A Town Hall Meeting**

**Moderator: Peter Corke, Queensland University of Technology, Australia**  
**Thursday, September 29, 2011, 16:45-17:45, Continental Ballroom 4-6**

IROS 2011 features a town hall meeting forum. The forum is an opportunity for conference attendees to provide feedback about the conference, and for future conference organizers to briefly present their vision of the meetings they are planning.

# Plenary Sessions

## Plenary Session I – Design

**Chair: Bernard Roth, Stanford University, California**  
**Tuesday, September 27, 2011, 12:30-13:45, Continental Ballroom**

The Design Plenary features three design pioneers (Hirose, Hirzinger, and Raibert) discussing their perspectives on various aspects of mechanism design. After initial presentations by the panelists, the chair (Roth) will moderate a panel discussion with the experts and the audience.



Professor **Shigeo Hirose** was born in Tokyo in 1947. He received his B.Eng. Degree with First Class Honors in Mechanical Engineering from Yokohama National University in 1971, and his M. Eng. and Ph.D. Eng. Degrees in Control Engineering from Tokyo Institute of Technology in 1973 and 1976, respectively. From 1976 to 1979 he was a Research Associate, and from 1979 to 1992 an Associate Professor. Since 1992 he has been a Professor in the Department of Mechanical and Aerospace Engineering at the Tokyo Institute of Technology. He is a fellow of JSME and IEEE. He is engaged in creative design of robotic systems. Prof. Hirose has been awarded more than twenty prizes.



Professor **Gerd Hirzinger** is director at DLR's institute for „Robotics and Mechatronics“, which is one of the biggest and most acknowledged Institutes in the field worldwide. He was prime investigator of the space robot technology experiment ROTEX, the first remote controlled robot in space, which flew onboard shuttle COLUMBIA in April 1993. He has published more than 600 papers in robotics. He received numerous national and international awards, e.g., in 1994 the Joseph-Engelberger-Award for achievements in robotic science and in 1995 the Leibniz-Award, the highest scientific award in Germany and the JARA (Japan robotics association) Award. In 2005 he received the IEEE Pioneer Award of the Robotics and Automation Society, and in 2007 the IEEE Field Award “Robotics and Automation”.



Dr. **Marc Raibert** was Professor of Electrical Engineering and Computer Science at MIT and a member of the Artificial Intelligence Laboratory from 1986 through 1995. He is co-founder and President of Boston Dynamics Inc, (BDI), which is located near MIT in Cambridge. Raibert's research is devoted to the study of systems that move dynamically, including physical robots and animated creatures. Raibert received a B.S. degree in Electrical Engineering from Northeastern University in 1973, and a Ph.D from the Massachusetts Institute of Technology in 1977. He is author of *Legged Robots That Balance* published by MIT Press, and is on the Editorial Board of the *International Journal of Robotics Research*. He is a fellow of the AAI.

## Plenary Session II – BioRobotics

**Chair: Professor Ruzena Bajcsy, University of California, Berkeley, California**  
**Wednesday, September 28, 2011, 12:30-13:45, Continental Ballroom**

The BioRobotics Plenary features three bio-robotics pioneers (Berthoz, Bülthoff, and Srinivasan) discussing their perspectives on various aspects of bio-robotics and biomimetic robotics. After initial presentations by the panelists, the chair (Bajcsy) will moderate a panel discussion with the experts and the audience.



Professor **Alain Berthoz** was born in 1939. He became Civil Engineer at École des Mines in 1963, Ph.D. in 1973. As researcher at (CNRS) (1966-1981), he established and coordinated the Neurosensory Physiology Laboratory (1981-1993). Since 1993, he is professor at Collège de France and director of UMR CNRS/Collège de France "Physiology of perception and action". He has over 200 scientific publications in international journals on physiology of sensori-motor functions and more specifically on the oculomotor system, the vestibular system, balance control, and movement perception. He had given about 90 invited talks across the world.



Professor **Heinrich Bülthoff** is scientific member of the Max Planck Society and director at the Max Planck Institute for Biological Cybernetics in Tübingen. He is head of the Department Human Perception, Cognition and Action in which a group of about 70 researchers investigate psychophysical and computational aspects of higher level visual processes in object and face recognition, sensory-motor integration, spatial cognition, and perception and action in virtual environments. He holds a Ph.D. degree in the natural sciences from the Eberhard-Karls-Universität in Tübingen. He was Assistant, Associate and Full Professor of Cognitive Science at Brown University in Providence from 1988-1993 before becoming director at the Max Planck Institute for Biological Cybernetics.



Professor **Mandyam Srinivasan** is at the Queensland Brain Institute and the School of Information Technology and Electrical Engineering of the University of Queensland. He holds an undergraduate degree in Electrical Engineering from Bangalore University, a Master's degree in Electronics from the Indian Institute of Science, a Ph.D. in Engineering and Applied Science from Yale University, a D.Sc. in Neuroethology from the Australian National University, and an Honorary Doctorate from the University of Zurich. Among his awards and honors are Fellowships of the Australian Academy of Science, of the Royal Society of London, and of the Academy of Sciences for the Developing World, an Inaugural Federation Fellowship, the 2006 Australia Prime Minister's Science Prize, and the 2008 U.K. Rank Prize for Optoelectronics.

## Plenary Session III – Self-Driving Cars

**Chair: Henrik Christensen, Georgia Tech, Atlanta, Georgia**  
**Thursday, September 29, 2011, 13:30-14:30, Continental Ballroom**

Most of us use a car every day. But unlike airplanes, which have been flying on autopilots for decades, cars are still driven manually - just the way they were driven 100 years ago. This talk will introduce the transformative concept of a self-driving car. Following early research in the 1990 in Germany and the US, and more recently the DARPA Challenges, this technology has now been advanced to a point where it is within reach of commercial realizations that may provide benefits to pretty much anyone who drives a car. At the core of this progress is a new generation of cutting-edge artificial intelligence, which enables a self-driving car to understand its environment and to interact with other traffic. The speaker will discuss the Google Self-Driving Car project, in which a fleet of self-driving cars navigated more than 160,000 miles on public roads in California and Nevada, including the downtowns of San Francisco and Los Angeles. The speaker will also discuss some of the societal implications of this new technology.



**Sebastian Thrun** is a Professor of Computer Science at Stanford University and director of the Stanford Artificial Intelligence Laboratory (SAIL). He led the development of the robotic vehicle Stanley that won the 2005 DARPA Grand Challenge. His team also developed Junior, which placed second at the DARPA Urban Challenge in 2007. Thrun led the development of the Google self-driving car and is well known for his work on probabilistic programming techniques in robotics, with applications including robotic mapping. He was elected into the National Academy of Engineering and also into the German Academy of Sciences Leopoldina in 2007. In 2011, he received the Max-Planck-Research Award and the inaugural AAAI Ed Feigenbaum Prize. Thrun received his Diplom (master's degree) in 1993 and a PhD (summa cum laude) in 1995 in computer science and statistics from the University of Bonn. He was on the CMU faculty from 1995 till 2003. Since 2003 he has been on the faculty of the Stanford Computer Science department. He is also a Google Fellow.



**Chris Urmson** is the head of engineering for Google's self-driving car program. He was the Director of Technology responsible for Boss, the vehicle that won the 2007 DARPA Urban Challenge. His team had vehicles finish 2nd and 3rd in the 2005 DARPA Grand challenge. Chris received his B.Eng. from the University of Manitoba in 1998 and his Ph.D in Robotics from Carnegie Mellon University in 2005. From 2006 - 2011 Chris was on the faculty of the Carnegie Mellon Robotics Institute.

# Social Event Updates

## Welcome Reception

A welcome reception will be offered to all IROS 2011 participants on **Monday, September 26, 18:30-20:00**. Half an hour after the end of the sessions, we will meet in the **Continental Ballroom** for light drinks and snacks.

## GOLD Lunch

On **Tuesday, September 27, at 11:30**, a lunch for all Graduates of the Last Decade (GOLD) will be organized at **Jasper's Corner Tap** (right across the street of the conference venue). This luncheon was initiated within the RAS Technical Activities Board as a mean to let graduates be aware of what the society has to offer and to network with each other. The opportunity is also used to present the structure of the society and introduce the various Technical Committees forming TAB. Free buffet lunch will be available on a first-come, first-served basis. RAS members will be prioritized. Not a member yet? Sign up now at [www.ieee-ras.org](http://www.ieee-ras.org)!

## Dinner Cruise on the Bay

San Francisco's skyline is most spectacular when seen from the water. On **Tuesday, September 27**, we will take you on an afternoon and dinner cruise on the San Francisco Belle, a beautiful three-leveled 292-foot sternwheeler with a unique Art Nouveau style. During the cruise, you will have ample opportunities to enjoy the views of the City and many of its most famous sights, such as Alcatraz, Angel Island, the Embarcadero, Fisherman's Wharf, Coit Tower, the skyscrapers of the Financial District, and – of course – the Golden Gate Bridge. Busses will leave at the **Taylor Street entrance** of the Hilton hotel at **16:00**, and we expect to be back at the hotel at 22:00.

## Lunch with Leaders

This event is organized by the IEEE Robotics and Automation Society (RAS) and will take place on **Wednesday, September 28, at 11:30** at **Jasper's Corner Tap**. Lunch with Leaders (LwL) was initiated by the Student Activities Committee with the aim to provide students with an opportunity to get in contact with leaders and get advice and mentoring on their career and research. RAS members will have first priority.

## Evening at the Museum with Picasso

This year, we have discovered a very special venue for the conference banquet. It will be held on the evening of **Wednesday, September 28**, in the de Young Museum. The muse-



um is situated in Golden Gate Park, which extends all the way to Ocean Beach, and which features many other attractions such as the Japanese Tea Garden, the Botanical Garden, and the California Academy of Sciences, to name but a few. As a special highlight, we will have exclusive access to the Picasso Exhibition. Transfer busses will leave at the **Taylor Street entrance** of the Hilton hotel at **18:30**, and we expect to be back at the hotel at 23:00.

### **Awards Ceremony**

All IROS 2011 participants are invited to attend the Awards Ceremony, on **Thursday, September 29, at 12:30**. All conference participants are welcome to join while the eight IROS 2011 Conference Awards will be presented in the **Continental Ballroom**.

### **Farewell Reception**

At the end of the conference, a reception will gather all IROS 2011 participants on **Thursday, September 29, 18:30-20:00**. Light food and drinks will be served in the **Continental Ballroom**.

## **Outreaching Youth Event**

**Thursday, September 29, 2011, 8:30-12:00, Union Square Room 22**

A special event geared to a select group of highly motivated high school students will take place on Thursday morning. The event will include robot demonstrations, a tour of exhibitions, a peek into a technical session or two, and opportunity to talk with graduate students working in the field of robotics, and an informative and entertaining talk on how to become a researcher in robotics.

## **Technical Tours**

To explore the inspiring atmosphere of the San Francisco Bay Area, three technical tours are offered during IROS 2011. Tickets are issued at a rate of \$20 per tour on a first-come-first-serve basis and are offered at the conference registration desk in front of the Continental Ballroom.

**Monday, September 26, 9:00–13:00 — University of California, Berkeley**

The **University of California** was chartered in 1868 and its flagship campus was established at Berkeley. Today UC Berkeley is the world's premier public university, according to the annual rankings by U.S. News & World Report, and Berkeley Engineering maintains

top rankings among engineering programs nationally, public or private. The tour will include visits of the Biomimetics Millisystems Lab (Fearing), the Lab for Automation Science and Engineering (Goldberg), the Hybrid Systems Lab (Tomlin), the Mechanical Systems Control Laboratory (Tomizuka), the Robot Learning Lab (Abbeel), the Vehicle Dynamics Lab (Hedrick), and the Tele-Immersion Lab (Bajcsy).

### **Friday, September 30, 9:00–16:00 — Adept Technology and Willow Garage**

**Adept Technology**, Inc. is a leading provider of intelligent vision-guided robotics systems and services. Founded in 1983, Adept Technology is the largest U.S.-based manufacturer of product lines including industrial robots, mobile robots (AGVs), configurable linear modules, machine controllers for robot mechanisms and other flexible automation equipment, machine vision, and systems and applications software. Adept provides specialized, cost-effective robotics systems and services to high-growth markets including Packaged Goods, Logistics, Life Sciences, Disk Drive/Electronics and Semiconductor/Solar; as well as to traditional industrial markets including machine tool automation and automotive components.

**Willow Garage** is a company dedicated to designing personal robots, developing open source robotics software, and advancing the open source personal robotics community. Willow Garage has developed a hardware platform called the PR2 (Personal Robot 2), and an open source software platform called ROS (Robot Operating System). The ROS software that Willow Garage contributes is BSD-licensed, making it completely free for anyone to use and change and free for other companies to commercialize. A major goal is to enable robotics innovation and ensure that the adoption of robotic technologies is a transparent process with positive societal impact. Willow Garage actively engages research labs and companies as partners, collaborators, customers and advisors in the development of both their hardware platform and open source software, and also supports researchers who would not otherwise have the bandwidth or funding to open source their work.

### **Saturday, October 1, 9:00–15:00 — Stanford University**

**Stanford University** is a private research university located in the heart of Silicon Valley. Stanford has a vibrant research and teaching program in the field of robotics, distributed in the Computer Science, Mechanical Engineering, and Bioengineering Departments. Research projects on intelligent systems and robots are conducted in the labs of David Camarillo, Mark Cutkosky, Oussama Khatib, Jean-Claude Latombe, Andrew Ng, Allison Okamura, Bernie Roth, Ken Salisbury, Sebastian Thrun, and Ken Waldron. The tour on the Stanford campus will include visits to several laboratories in different departments, highlighting current research in autonomous robots, human-friendly robot design, bio-inspired robots, haptics, and medical robotics. We will provide hands-on and interactive demonstrations, and show collaborative spaces that facilitate interdisciplinary robotics research. Lunch will be served during the campus tour.