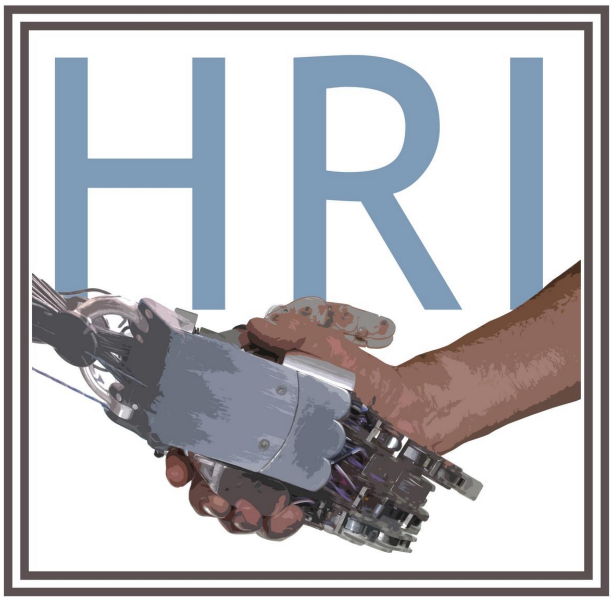
Second International Conference on Human-Robot Interaction (HRI 2007)

9-11 March 2007

Arlington, Virginia USA



www.hri2007.org

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Cover note: The HRI logo was created in 2005 by Billy Howell (Institute for Human-Machine Cognition, IHMC) under the direction of Jeff Bradshaw (IHMC). Permission to use the robot hand image has been granted by the Shadow Robot Company.

Welcome

It is our great pleasure to welcome you to the Second ACM/IEEE International Conference on Human-Robot Interaction (HRI 2007). HRI is a highly selective annual conference that seeks to showcase the very best research and thinking in human-robot interaction. Human-robot interaction is inherently inter-disciplinary, and the conference sought papers from researchers in robotics, human-factors, ergonomics, human-computer interaction, cognitive psychology, and other fields. The mission of the conference is to create a common venue for this broad set of researchers.

This year's conference theme is "Robot as Team Member". Robots are used in critical domains as search and rescue, military theater, mine and bomb detection, scientific exploration, law enforcement, and hospital care. Such robots must coordinate their behaviors with human team members; they are more than mere tools but rather quasi-team members whose tasks have to be integrated with those of humans. HRI 2007 is dedicated to these and other issues in human and robot interaction, highlighting the importance of building core science and understanding the social and technical issues in human-robot interaction in the context of teams and groups.

Of the 93 submissions, the program committee accepted 22 papers and 26 posters that cover a variety of topics, among them field studies of robots in public spaces, operator-robot rescue teams, attributions of robot behavior, and human-robot dialogue. The program includes paper presentations, a video session, two interactive poster sessions, panels on robots in teams and the future of HRI research, and keynote speeches by human teamwork expert, J. Richard Hackman (Harvard University), and by Hiroshi Ishiguro (Osaka University and ATR). We hope that these proceedings will serve as a valuable reference for HRI researchers and students.

Putting together HRI 2007 was a team effort. We thank the authors, keynote speakers, and panelists for providing the content of the program. We are very grateful to the program committee and external reviewers, who worked very hard in reviewing papers and providing suggestions for their improvement. We would also like to thank Julie A. Adams, this year's Finance Chair; Dennis Perzanowski, Local Arrangements Chair; Candace Sidner, Registration Co-Chair; Marge Skubic, Registration Co-Chair; Rene dePontbriand, Publicity Co-Chair; François Michaud, Publicity Co-Chair; Holly Yanco, Exhibitions Chair; Samuel Blisard, Tutorials Chair; Christoph Bartneck, Video Co-Chair, and Takayuki Kanda, Video Co-Chair. Special thanks go to Michael Goodrich for maintaining the HRI 2007 web site and for his efforts in helping coordinate the conference. Finally, we thank our sponsors, ACM SIGCHI, ACM SIGART, IEEE, Honda, Idaho National Laboratory, iRobot, the Naval Research Laboratory and Microsoft Robotics, for their support of this meeting, and the National Science Foundation for supporting the graduate student workshop.

We hope that you will find this program interesting and thought provoking and that the conference will provide you with a valuable opportunity to share ideas with other researchers across many disciplines from around the world.

Sincerely,

Alan C. Schultz *(Naval Research Laboratory)*
General Co-Chair

Cynthia Breazeal *(Massachusetts Institute of Technology)*
General Co-Chair

Terry Fong *(NASA Ames Research Center)*
Program Co-Chair

Sara Kiesler *(Carnegie Mellon University)*
Program Co-Chair

Technical program at a glance

	Friday (9 March 2007)	Saturday (10 March 2007)	Sunday (11 March 2007)
08:30	Welcome	Announcements	Summary of the Young Researchers Workshop
09:00 09:30	**Richard Hackman** *Harvard University*	**Hiroshi Ishiguru** *Osaka University and ATR*	**What is the future of HRI ?** *Moderator: Brian Scassellati*
	Short Break (15 min)	Short Break (15 min)	Short Break (15 min)
	Teamwork I *Chair: Pamela Hinds*	**Learning** *Chair: François Michaud*	**Social Robotics** *Chair: Kerstin Dautenhahn*
10:00	Effects of anticipatory action on human-robot teamwork: efficiency, fluency, and perception of team	Learning by demonstration with critique from a human teacher	How robotic products become social products: an ethnographic study of cleaning in the home
10:30	Human control for cooperating robot teams	Efficient model learning for dialog management	Humanoid robots as a passive-social medium: a field experiment at a train station
11:00	Coffee Break (30 min)	Coffee Break (30 min)	Coffee Break (30 min)
11:30	**Robot Adaptation** *Chair: Matthius Scheutz*	**Interfaces** *Chair: Candace Sidner*	**People's Experience** *Chair: Holly Yanco*
	Natural person-following behavior for social robots	Using vision, acoustics, and natural language for disambiguation	Comparing a computer agent with a humanoid robot
12:00	Speed adaptation for a robot walking with a human (poster)	Robots as interfaces to haptic and locomotor spaces (poster)	Experiments with a robotic computer: body, affect and cognition interactions
	Robotic etiquette: results from user studies involving fetch & carry (poster)	Robot expressionism through cartooning (poster)	
12:30 13:00 13:30	Lunch (90 min)	Lunch (90 min)	Lunch (90 min)
	Observation and Metrics *Chair: Takayuki Kanda*	**Anthropomorphic Robots** *Chair: Peter Kahn*	**Teamwork II** *Chair: Christoph Bartneck*
14:00	Managing autonomy in robot teams: observations from four experiments	To kill a mockingbird robot	RSVP: An investigation of Remote Shared Visual Presence as common ground for human-robot teams
14:30	Developing performance metrics for the supervisory control of multiple robots	A dancing robot for rhythmic social interaction	A field experiment of autonomous mobility: operator workload for one and two robots
15:00	Adapting GOMS to model human-robot interaction	The perceptual robotic percussionist: new developments in form, mechanics, perception and interaction design	**Video Session** *Chairs: Christoph Bartneck and Takayuki Kanda*
15:30	Coffee Break (30 min)	Coffee Break (30 min)	Awards / Closing Remarks End of HRI 2007

	Friday (9 March 2007)	Saturday (10 March 2007)
16:00	**What is a robot?** *Chair: Julie Adams*	**Adaptation and Attention** *Chair: Dennis Perzanowski*
	Interactive robot task training through dialog and demonstration	Using proprioceptiive sensor for behavioral adaptation
16:30	**Robot: Tool or Teammate ?** *Moderator: Alan Schultz (NRL)* *Panelists:* *Jeff Bradshaw (IHMC)* *Terry Fong (NASA)* *Michael A. Goodrich (BYU)* *Victoria Groom (Stanford)* *Dave Kaber (NCSU)*	Improving human-robot interaction through adaptation to the auditory scene
17:00		Group attention control for communication robots
17:30	Break (30 min)	Break (30 min)
18:00	**Posters / reception** *Host: Robin Murphy*	**Posters / reception** *Host: Geb Thomas*
	Android as a telecommunication medium with human-like presence	Autonomous behavior design for robot appliance
	Daisy, Daisy, give me your answer do! - switching off a robot	A cognitive robotics approach to comprehending human language and behaviors
	Directed stigmergy-based control for multi-robot systems	Combining ubiquitous and on-board audio sensing for HRI
	Incremental learning of gestures by imitation in a humanoid robot	Elements of a spoken language programming interface for robots
	On-line behaviour classification and adaptation to human-robot interaction styles	Evaluating a scalable multiple robot interface
	Robotic etiquette: results from user studies involving a fetch and carry task	Improving a robot's ability to give direction with awareness of task progress and human gaze
19:00	Robots as interfaces to haptic and locomotor spaces	
	Spatial dialogue for space system autonomy	Incremental natural language processing for HRI
	Speed adaptation for a robot walking with a human	Influence of perspective-taking & mental rotation abilities in space teleop.
	The future of HRI: maps of the field and future directions	LASSOing HRI: analyzing SA in map-centric and video-centric interfaces
	The RUBI project: a progress report	Non-facial/non-verbal methods of affective expression as applied to robot-assisted victim assessment
	Tracking human motion and actions for interactive robots	Realizing Hinokio: candidate req. for physical avatar systems
	User-centered approach to path planning of cleaning robots: analyzing user's cleaning behavior	Robot expressionism through cartooning
20:00	End of Friday	End of Saturday

Conference Information

Exhibits (Friday, Saturday, and Sunday: 08:30 – 20:00) will be located in Ballrooms A and B.

Extra events (Sunday: 16:00 – 17:30) will occur in F. Scott Fitzgerald Ballroom C and Ballrooms D and E.

Poster Sessions (Friday and Saturday: 18:00 – 20:00) will occur in Ballrooms A and B.

Receptions (Friday and Saturday: 18:00 – 20:00) will be located in Ballrooms A and B and in Pre-function A, C, and D.

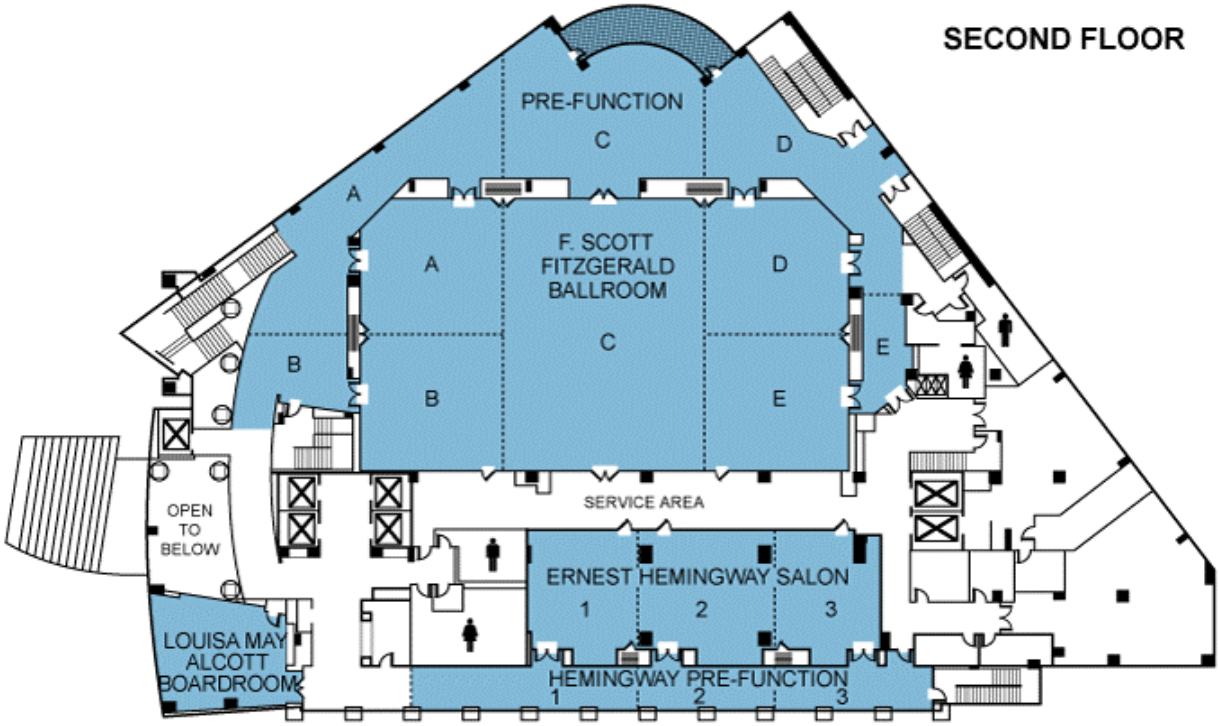
Refreshments for Coffee Breaks will be located in Ballrooms A and B.

Technical Sessions (Friday and Saturday: 08:30 – 17:30; Sunday: 08:30 – 16:00) will occur in F. Scott Fitzgerald Ballroom C and Ballrooms D and E.

Tutorials (Thursday: 08:30 – 12:30 and 13:30 – 17:30) will occur in Ballroom D.

Young Researchers Reception (Thursday: 17:00 – 19:00) will occur in Ballroom B.

Young Researchers Workshop (Thursday: 08:00 – 17:00) will occur in Ballroom E.



Breaks and Lunches

Short morning breaks are scheduled from 09:45 to 10:00 with Coffee Breaks at 11:00 to 11:30 each morning of the conference. Afternoon Coffee Breaks are on Friday and Saturday afternoons at 15:30 to 16:00. Lunches are scheduled each day from 12:30 to 14:00. A list of some local area restaurants and eateries is included in your registration packet. Most establishments are within a short walk of the hotel; however, check with someone familiar with the area (someone at the registration desk, the hotel concierge, a local resident).

Exhibits

Exhibits will be available throughout the conference in Ballrooms A and B.

Internet

Wireless Internet access is available in all hotel suites and rooms at a fee of $9.95 USD for 24 hours. Wireless Internet access is available free of charge in the hotel lobby, the restaurant bar and lounge, and in Starbucks. Note: there is no wireless access in any of the meeting rooms or ballrooms, nor anywhere on the second floor.

Medical Services

If you need urgent medical assistance, please contact one of the conference staff or hotel personnel immediately. There is also 24-hour hotel security.

No Smoking

The Westin Gateway of Arlington is a smoke-free hotel. Smoking is strictly prohibit anywhere inside the hotel, including hotel rooms. If there is evidence of smoking in hotel rooms, a surcharge of $200 USD will be added to room charges. Smoking is limited to areas outside the building. All areas on the ground level around the perimeter of the building are designated smoking areas, as is the exterior balcony on the Second Floor. There is also a courtyard adjacent to the hotel.

Parking

Hotel valet parking, $15.00 USD per day (no in-and-out) and $20.00 USD per day (in-and-out), is available for guests and visitors. There is also a self-parking garage on N. Vermont Street, directly opposite the main vehicular entrance to the hotel at "901"—not indicated on the map. Several garages are also located nearby (indicated by the letter "P" on the map). Public garages average from $8.00 to $13.00 USD maximum per day and are open 24 hours, 7 days a week, but we urge you to check with the individual venues beforehand.

Poster Presenters

If you are presenting a poster, please make sure the poster is ready by the time the poster session starts. Poster boards will be set up in Ballrooms A and B and available after noon (12:00) on Friday and Saturday. We will provide pushpins for mounting posters. Please do not use any other material for mounting purposes (e.g. adhesive or tape). Please take down your poster at the end of your session if you wish to keep it. Power strips (120 V) will be located near the poster boards to allow laptop use for presentations, if desired.

Registration

The Conference Desk will be staffed for registration and information services on the Second Floor of The Westin Gateway Hotel in Pre-function C on the following schedule:

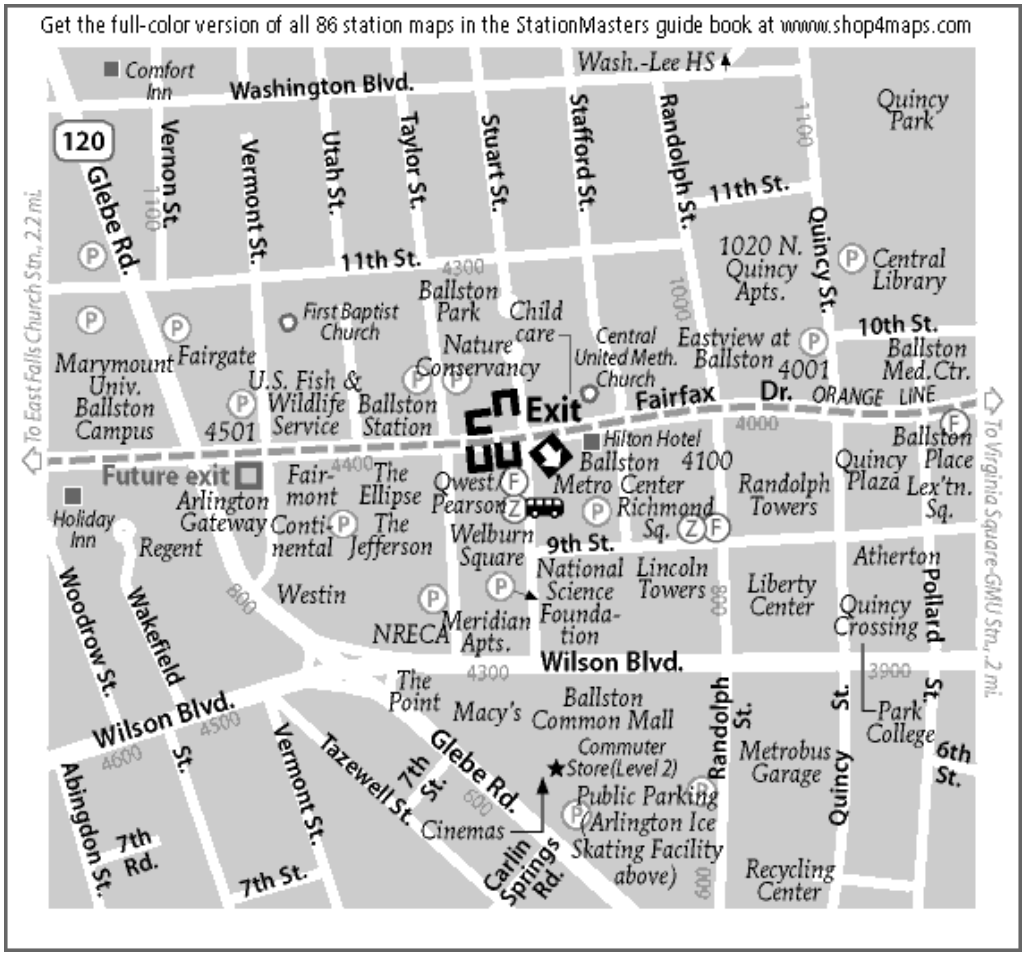
Friday, March 9	07:30 – 12:00
Saturday, March 10	08:00 – 12:00

Written messages can be posted at the Conference Desk. If messages are of an urgent nature, please contact one of the conference personnel.

Public Transportation

Metro is Washington, DC's area rapid transit system. The District, as well as portions of Virginia and Maryland, are easily accessible via Metro. There is a Metro map provided in your registration packet. General information is available at http://www.wmata.com/ but check individual stations for hours of operation and fares.

The nearest Metro station is Ballston. It is located one and a half blocks from the hotel.



Bus service is also available one block away at the Ballston Common Mall. There are no airport shuttles serving the hotel.

The hotel concierge can telephone taxis. Allow at least a half hour for the taxi to arrive.

Receptions

Hors d'oeuvres and a cash bar will be offered. Receptions are included in the registration fee (admission tickets can be found in the registration packets). Tickets for additional guests are available at Registration. We graciously acknowledge the kind support of Microsoft Corporation and Honda Motor Company, Ltd.

Paper Abstracts (presentation order)

Effects of Anticipatory Action on Human-Robot Teamwork: Efficiency, Fluency, & Perception of Team
Guy Hoffman and Cynthia Breazeal

A crucial skill for fluent action meshing in human team activity is a learned and calculated selection of anticipatory actions. We believe that the same holds for robotic teammates, if they are to perform in a similarly fluent manner with their human counterparts. In this work, we propose an adaptive action selection mechanism for a robotic teammate, making anticipatory decisions based on the confidence of their validity and their relative risk. We predict an improvement in task efficiency and fluency compared to a purely reactive process. We then present results from a study involving untrained human subjects working with a simulated robot using our system.

Human Control for Cooperating Robot Teams
Jijun Wang and Michael Lewis

Human control of multiple robots has been characterized by the average demand of single robots on human attention or the distribution of demands from multiple robots. When robots are allowed to cooperate autonomously, however, demands on the operator should be reduced by the amount previously required to coordinate their actions. The present experiment compares control of small robot teams in which cooperating robots explored autonomously, were controlled independently by an operator or through mixed initiative as a cooperating team. Mixed initiative teams found more victims and searched wider areas than either fully autonomous or manually controlled teams. Operators who switched attention between robots more frequently were found to perform better in both manual and mixed initiative conditions.

Natural Person-Following Behavior for Social Robots
Rachel Gockley, Jodi Forlizzi, and Reid Simmons

We are developing robots with socially appropriate spatial skills not only to travel around or near people, but also to accompany people side-by-side. As a step toward this goal, we are investigating the social perceptions of a robot's movement as it follows behind a person. This paper discusses our laser-based person-tracking method and two different approaches to path following: direction-following and path-following. While both algorithms have similar characteristics in terms of tracking performance and following distances, participants in a pilot study rated the direction-following behavior as significantly more human-like and natural than the path-following behavior. We argue that the path-following method may still be more appropriate in some situations, and we propose that the ideal behavior may be a hybrid approach, with the robot automatically selecting which method to use.

Managing Autonomy in Robot Teams: Observations from Four Experiments
Michael A. Goodrich, Timothy W. McLain, Jacob W. Crandall, Jeffrey D. Anderson, and Jisang Sun

It is often desirable for a human to manage multiple robots. Autonomy is required to keep workload within tolerable ranges, and dynamically adapting the type of autonomy may be useful for responding to environment and workload changes. We identify two management styles for managing multiple robots and present results from four experiments that have relevance to dynamic autonomy within these two management styles. These experiments, which involved 80 subjects, suggest that individual and team autonomy benefit from attention management aids, adaptive autonomy, and proper information abstraction.

Developing Performance Metrics for the Supervisory Control of Multiple Robots
Jacob W. Crandall and M. L. Cummings

Efforts are underway to make it possible for a single operator to effectively control multiple robots. In these high workload situations, many questions arise including how many robots should be in the team (fan-out), what level of autonomy should the robots have, and when should this level of autonomy change (i.e., dynamic autonomy). We propose that a set of metric classes should be identified that can adequately answer these questions. Toward this end, we present a potential set of metric classes for human-robot teams consisting of a single human operator and multiple robots. To test the usefulness and appropriateness of this set of metric classes, we conducted a user study with simulated robots. Using the data obtained from this study, we explore the ability of this set of metric classes to answer these questions.

Adapting GOMS to Model Human-Robot Interaction
Jill Drury, Jean Scholtz, and David Kieras

A formal interaction modeling technique known as Goals, Operators, Methods, and Selection rules (GOMS) is well established in human-computer interaction as a cost-effective way of evaluating designs without the participation of end users. This paper explores the use of GOMS for evaluating HRI. We provide a case study in the urban search-and-rescue domain and raise issues for developing GOMS models that have not been previously addressed. Further, we provide rationale for selecting different types of GOMS modeling techniques to help the analyst model human-robot interfaces.

Interactive Robot Task Training Through Dialog and Demonstration
Paul E. Rybski, Kevin Yoon, Jeremy Stolarz, and Manuela M. Veloso

Effective human-robot interfaces that mimic how humans interact with one another could ultimately lead to robots being accepted in a wider domain of applications. We present a framework for interactive task training of a mobile robot where the robot learns how to do various tasks while observing a human. In addition to observation, the robot listens to the human's speech and interprets the speech as behaviors to be executed. This is especially important where individual steps of a given task may have contingencies that have to be dealt with depending on the situation. In this paper, we describe the task-training framework, describe how environmental context and communicative dialog help the robot learn the task, and illustrate the utility of this approach with experimental case studies.

Learning by Demonstration with Critique from a Human Teacher
Brenna Argall, Brett Browning, and Manuela Veloso

Learning by demonstration can be a powerful and natural tool for developing robot control policies. That is, instead of tedious hand coding, a robot may learn a control policy by interacting with a teacher. In this work we present an algorithm for learning by demonstration in which the teacher operates in two phases. The teacher first demonstrates the task to the learner. The teacher next critiques learner performance of the task. We argue that this method is particularly well suited to human teachers, who are generally better at assigning credit to performances than to algorithms. We have applied this algorithm to the simulated task of a robot intercepting a ball.

Efficient Model Learning for Dialog Management
Finale Doshi and Nicholas Roy

Intelligent planning algorithms such as Partially Observable Markov Decision Processes (POMDPs) have succeeded in dialog management applications because of their robustness to the inherent uncertainty of human interaction. Like all dialog planning systems, however, POMDPs require an accurate user model. In this paper, we take a Bayesian approach to learning the user model simultaneously the dialog management problem. We demonstrate a robust dialog manager that learns from interaction data, out-performing a hand-coded model in simulation and in a robotic wheelchair application.

Using Vision, Acoustics, and Natural Language for Disambiguation
Benjamin Fransen, Vlad Morariu, Eric Martinson, Samuel Blisard, Matthew Marge, Scott Thomas, Alan Schultz, and Dennis Perzanowski

Creating a human-robot interface is a daunting experience. Capabilities and functionalities of the interface are dependent on the robustness of many different sensor and input modalities. In this research, we are integrating several modalities to leverage the existing strengths of each modality and overcome individual weaknesses. We are using visual, acoustic, and linguistic inputs in various combinations to solve such problems as the disambiguation of referents (objects), localization of human speakers, and determination of the source of utterances and appropriateness of responses. This paper describes our system and the integration of the various modules.

To Kill A Mockingbird Robot
Christoph Bartneck, Marcel Verbunt, Omar Mubin, and Abdullah Al Mahmud

Robots are being introduced in our society but their social status is still unclear. A critical issue is if the robot's exhibition of intelligent life-like behavior leads to the users' perception of animacy. The ultimate test for the life-likeness of a robot is to kill it. We conducted an experiment in which the robot's intelligence and the participants' gender were the independent variables and the users' destructive behavior of the robot the dependent variables. We discuss the encountered problems and the possible application of this animacy measuring method.

A Dancing Robot for Rhythmic Social Interaction
Marek P. Michalowski, Hideki Kozima, Selma Sabanovic

This paper describes a robotic system that uses dance as a form of social interaction to explore the properties and importance of rhythmic movement in general social interaction. The system consists of a small creature-like robot whose movement is controlled by a rhythm-based software system. Environmental rhythm can be extracted from auditory or visual sensory stimuli, and the robot synchronizes its movement to a dominant rhythm. The system was demonstrated and evaluated in interactions with children. We found that the robot's synchrony has an effect on children's degree of interactive involvement and observed a number of interesting styles of interactive play.

The Interactive Robotic Percussionist: New Devel. in Form, Mechanics, Perception & Interaction Design
Gil Weinberg and Scott Driscoll

We present new developments in the improvisational robotic percussionist project, aimed at improving human-robot interaction through design, mechanics, and perceptual modeling. Our robot, named Haile, listens to live human players, analyzes perceptual aspects in their playing in real-time, and uses the product of this analysis to play along in a collaborative and improvisatory manner. It is designed to combine the benefits of computational power in algorithmic music with the expression and visual interactivity of acoustic playing.

Using Proprioceptive Sensors for Categorizing Human-Robot Interactions
T. Salter, F. Michaud, D.Létourneau, D.C. Lee, and I.P. Werry

Increasingly researchers are looking outside of normal communication channels (such as video and audio) to provide additional forms of communication or interaction. Amongst the new channels being investigated is the detection of touch using infrared, proprioceptive and temperature sensors. Our work aims at developing a system that can detect natural touch or interaction coming from children playing with a robot, and adapt to this interaction. This paper reports trials carried out using Roball, a spherical mobile robot, demonstrating how sensory data patterns can be identified in human-robot interaction, and exploited for achieving behavioral adaptation.

Improving Human-Robot Interaction Through Adaptation to the Auditory Scene
Eric Martinson and Derek Brock

Effective communication with a mobile robot using speech is a difficult problem even when you can control the auditory scene. Robot ego-noise, echoes, and human interference are all common sources of decreased intelligibility. In real-world environments, however, these common problems are supplemented with many different types of background noise sources. In this work, we seek to overcome these problems by applying robotic advantages of sensing and mobility to a text-to-speech interface.

Group Attention Control for Communication Robots with Wizard of Oz Approach
Masahiro Shiomi, Takayuki Kanda, Satoshi Koizumi, Hiroshi Ishiguro, and Norihiro Hagita

This paper describes a group attention control (GAC) system that enables a communication robot to simultaneously interact with many people. GAC is based on controlling social situations and indicating explicit control to unify all purposes of attention. We implemented a semi-autonomous GAC system into a communication robot that guides visitors to exhibits in a science museum and engages in free-play interactions with them. The GAC system's effectiveness was demonstrated in a two-week experiment in the museum. We believe these results will allow us to develop interactive humanoid robots that can interact effectively with groups of people.

How Robotic Products Become Social Products: An Ethnographic Study of Cleaning in the Home
Jodi Forlizzi

The home is an interesting place to study the adoption and use of these systems. The home provides challenges from both technical and interaction perspectives. In addition, the home is a seat for many specialized human behaviors and needs, and has a long history of what is collected and used to functionally, aesthetically, and symbolically fit the home. To understand the social impact of robotic technologies in the home, this paper presents an ethnographic study of consumer robots. Six families' experience of floor cleaning after receiving a new vacuum (a Roomba robotic vacuum or the Flair, a handheld upright) was studied. The results of this study, while initial, generate implications for how robots should be designed for the home.

Humanoid Robots as a Passive-Social Medium: A Field Experiment at a Train Station
Aaron Powers, Sara Kiesler, Susan Fussell, and Cristen Torrey

HRI researchers interested in social robots have made large investments in humanoid robots. There is still sparse evidence that peoples' responses to robots differ from their responses to computer agents, suggesting that agent studies might serve to test HRI hypotheses. To help us understand the difference between people's social interactions with an agent and a robot, we experimentally compared people's responses in a health interview with a computer agent projected either on a computer monitor or life-size on a screen, a remote robot projected life-size on a screen, and a co-located robot in the same room. We discuss tradeoffs for HRI research of using collocated robots, remote robots, and computer agents as proxies of robots.

Comparing a Computer Agent with a Humanoid Robot
Aaron Powers, Sara Kiesler, Susan Fussell, and Cristen Torrey

HRI researchers interested in social robots have made large investments in humanoid robots. There is still sparse evidence that peoples' responses to robots differ from their responses to computer agents, suggesting that agent studies might serve to test HRI hypotheses. To help us understand the difference between people's social interactions with an agent and a robot, we experimentally compared people's responses in a health interview with a computer agent projected either on a computer monitor or life-size on a screen, a remote robot projected life-size on a screen, or a collocated robot in the same room. In this paper, we present our results, and discuss tradeoffs for HRI research of using collocated robots, remote robots, and computer agents as proxies of robots.

Experiments with a Robotic Computer: Body, Affect and Cognition Interactions
Cynthia Breazeal, Andrew Wang, and Rosalind Picard

We present RoCo, the first robotic computer designed with the ability to move its monitor in subtly expressive ways that respond to and encourage its user's own postural movement. We use RoCo in a user study to explore whether a computer's "posture" can influence its user's subsequent posture, and if the interaction of the user's body state with their affective state during a task leads to improved task measures such as persistence in problem solving. We believe this is possible in light of theories that link physical posture and its influence on affect and cognition.

RSVP: An Investigation of Remote Shared Visual Presence as Common Ground for Human-Robot Teams
Jenny Burke and Robin Murphy

This study presents mobile robots as a way of augmenting communication in distributed teams through a remote shared visual presence (RSVP) consisting of the robot's view. By giving all team members access to the shared visual display provided by robot situated in a remote workspace, the robot can serve as a source of common ground for the distributed team. In a field study examining the effects of remote shared visual presence on team performance in collocated and distributed Urban Search & Rescue technical search teams, data were collected from 25 dyadic teams comprised of US&R task force personnel drawn from high-fidelity training exercises.

A Field Experiment of Autonomous Mobility: Operator Workload for One and Two Robots
Susan G. Hill and Barry Bodt

An experiment was conducted on aspects of human-robot interaction in a field environment using the U.S. Army's Experimental Unmanned Vehicle (XUV). Goals of this experiment were to examine the use of scalable interfaces and to examine operator span of control when controlling autonomous unmanned ground vehicles. We collected workload ratings from two Soldiers after they had performed missions that included monitoring, downloading and reporting on simulated reconnaissance, surveillance, and target acquisition (RSTA) images, and responding to unplanned operator intervention requests from the XUV.

Video Session: Human Robot Interaction Caught on Film
Christoph Bartneck and Takayuki Kanda

The Human Robot Interaction 2007 conference hosts a video session, in which movies of interesting, important, illustrative, or humorous HRI research moments are shown. This paper summarizes the abstracts of the presented videos. Robots and humans do not always behave as expected and the results can be entertaining and even enlightening – therefore instances of failures have also been considered in the video session. Besides the importance of the lessons learned and the novelty of the situation, the videos have also an entertaining value.

Poster Abstracts (alphabetical order)

A Cognitive Robotics Approach to Comprehending Human Language and Behaviors
D. Paul Benjamin, Deryle Lonsdale, and Damian Lyons

The ADAPT project is a collaboration of researchers in linguistics, robotics and artificial intelligence at three universities. We are building a complete robotic cognitive architecture for a mobile robot designed to interact with humans in a range of environments, and which uses natural language and models human behavior. This paper concentrates on the HRI aspects of ADAPT, and especially on how ADAPT models and interacts with humans.

Android as a Telecommunication Medium With Human-Like Presence
Daisuke Sakamoto, Takayuki Kanda, Tetsuo Ono, Hiroshi Ishiguro, and Norihiro Hagita

In this research, we realize human telepresence with a remote-controlled android system called Geminoid HI-1. Experimental results confirm that participants felt stronger presence of the operator when he talked through the android than when he appeared on a monitor in a videoconference system. In addition, participants talked with the robot naturally and evaluated its human likeness as equal to a man on a video monitor. In this paper, we discuss a remote-control system for telepresence that uses a human-like android robot as a new telecommunication medium.

Autonomous Behavior Design for Robot Appliance
Hyunjeong Lee, Hyun Jin Kim, and Chang Soo Kim

A *robot appliance* is a robot that does house work autonomously with its own active movement. The behavior of a robot appliance is a serious concern because its autonomic behavior is composed of HRI and robot-environment interaction. In order to present the progress of robots' behaviors and the changes as they are, we adopted the “Robot Behavior Diagram” that is one of the conventional design methods. By doing so, we created the scenarios of autonomic robot behaviors. We applied this method to the cleaning robot, one of the robot appliances, in redesigning its behavior. We also evaluated the suitability of the design method.

Combining Ubiquitous and On-Board Audio Sensation for Human-Robot Interaction
Simon Thompson, Satoshi Kagami, Yoko Sasaki, Yoshifumi Nishida and Tadashi Enomoto

This paper reports on the development of a mobile robot system for operation within a house equipped with a ubiquitous sensor network. Human robot interaction is achieved through the combination of on-robot audio and laser range sensing and additional audio sensors mounted in the ceiling of the ubiquitous environment. The ceiling mounted microphone arrays can be used to summon a mobile robot from a location outside the robot's range of hearing. After the robot autonomously navigates to the desired location, the on-board microphone array can be used to locate the sound source and to recognize a series of greetings and commands.

Daisy, Daisy, Give Me Your Answer Do! – Switching Off a Robot
Christoph Bartneck, Michel van der Hoek, Omar Mubin, and Abdullah Al Mahmud

Robots can exhibit life-like behavior, but are according to traditional definitions not alive. Current robot users are confronted with an ambiguous entity and it is important to understand the users’ perception of these robots. This study analyzes if a robot's intelligence and its agreeableness influence its perceived animacy. The robot's animacy was measured, amongst other measurements, by the users' hesitation to switch it off. The results show that participants hesitated three times as long to switch off an agreeable, intelligent robot as compared to a non-agreeable, unintelligent robot. The robots' intelligence had a significant influence on its perceived animacy. Our results suggest that interactive robots should be intelligent and exhibit an agreeable attitude to maximize perceived animacy.

Directed Stigmergy-Based Control for Multi-Robot Systems
Fitzgerald Steele, Jr. and Geb Thomas

Multi-robot systems are particularly useful in tasks that require searching large areas such as planetary science exploration, urban search and rescue, or landmine remediation. In order to overcome the inherent complexity of controlling multiple robots, the user must be able to give high-level, goal driven direction to the robot team. Inspiration from natural decentralized systems guides the development of a computer simulation for stigmergy-based control of multi-robot system, and the interface with which an operator can interact and control mobile robots. This paper describes a basic stigmergy-based control system and an innovative Directed Stigmergy control system that facilitates operator control of the robot team in an interesting and surprisingly effective way.

Elements of a Spoken Language Programming Interface for Robots
Tim Miller, Andy Exley, and William Schuler

In many settings, such as home care or mobile environments, demands on users' attention, or users' anticipated level of formal training, or other on-site conditions will make standard keyboard and monitor-based robot programming interfaces impractical. In such cases, a spoken language interface may be preferable. However, the open-ended task of programming a machine is very different from the sort of closed-vocabulary, data-rich applications (e.g. call routing) for which most speaker-independent spoken language interfaces are designed. This paper will describe some of the challenges of designing a spoken language programming interface for robots, and will present an approach that uses these semantic-level resources as extensively as possible in order to address these challenges.

Evaluating a Scalable Multiple Robot Interface
Curtis M. Humphrey, Christopher Henk, George Sewell, Brian W. Williams, and Julie A. Adams

As multiple robot systems become more common, it is necessary to develop scalable human-robot interfaces that permit the inclusion of additional robots without reducing the overall system performance. This work focused on the development of a scalable interface for a single human-multiple robot system. This interface introduces a relational "halo" display that augments a camera view to promote situational awareness and the management of multiple robots by providing information regarding the robots' relative locations with respect to a selected robot. An evaluation was conducted to determine the scalability of the interface focusing on the effects of increasing the number of robots on workload, situation awareness, and robot usage.

Exploring Adaptive Dialogue Based on a Robot's Awareness of Task Progress and Human Gaze
Cristen Torrey, Aaron Powers, Susan R. Fussell, and Sara Kiesler

When a robot provides direction as a guide, an assistant, or as an instructor, the robot may have to interact with people of different backgrounds and skill sets. Different people require information adapted to their level of understanding. In this paper, we explore the use of two simple forms of awareness that a robot might use to infer that a person needs further verbal elaboration during a tool selection task. We investigated the effects of these two types of awareness on performance time, selection mistakes, and the number of questions people asked the robot. The mixed results of our investigation suggest that more research is necessary before we can understand how awareness of task delay and awareness of gaze can be successfully implemented in human-robot dialogue.

Incremental Learning of Gestures by Imitation in a Humanoid Robot
Sylvain Calinon and Aude Billard

We present an approach to teach incrementally human gestures to a humanoid robot. By using active teaching methods that puts the human teacher "in the loop" of the robot's learning, we show that interacting socially with the robot can efficiently transfer the essential characteristics of a gesture. In a first phase, the robot observes the user demonstrating the skill while wearing motion sensors. The motion of his/her two arms and head are recorded by the robot, projected in a latent space of motion and encoded probabilistically in a Gaussian Mixture Model (GMM). In a second phase, the user helps the robot refine its gesture by kinesthetic teaching, i.e. by grabbing and moving its arms throughout the movement to provide the appropriate scaffolds. We present experiments to show that different modalities can be combined efficiently to teach basketball officials' signals to a humanoid robot.

Incremental Natural Language Processing for HRI
Timothy Brick and Matthias Scheutz

Robots that interact with humans face to face using natural language need to be responsive to the way humans use language in those situations. We propose a psychologically-inspired natural language processing system for robots which performs incremental semantic interpretation of spoken utterances, integrating tightly with the robot's perceptual and motor systems.

Influence of Perspective-Taking and Mental Rotation Abilities in Space Teleoperation
M. Alejandra Menchaca-Brandan, Andrew M. Liu, Charles M. Oman, and Alan Natapoff

Operator performance during Space Shuttle and International Space Station robotic arm training can differ dramatically among astronauts. The difficulty making appropriate camera selections and accurate use of hand controllers may be rooted in relating the various reference frames used by the displays, hand controllers and robot arm. In this paper, we examine whether the origin of such individual differences can be found in certain components of spatial ability.

LASSOing HRI: Analyzing Situation Awareness in Map-Centric and Video-Centric Interfaces
Jill L. Drury, Brenden Keyes and Holly A. Yanco

Good situation awareness (SA) is especially necessary when robots and their operators are not collocated, such as in urban search and rescue (USAR). This paper compares how SA is attained in two systems: one that has an emphasis on video and another that has an emphasis on a three-dimensional map. To analyze the utterances made by the participants, we developed a SA analysis technique, called LASSO, which includes five awareness categories: location, activities, surroundings, status, and overall mission. Using our analysis technique, we show that a map-centric interface is more effective in providing good location and status awareness while a video-centric interface is more effective in providing good surroundings and activities awareness.

Non-Facial/Non-Verbal Methods of Affective Expression as Applied to Robot-Assisted Victim Assessment
Cindy L. Bethel and Robin R. Murphy

This work applies a previously developed set of heuristics for determining when to use non-facial/non-verbal methods of affective expression to the domain of a robot being used for victim assessment in the aftermath of a disaster. Robot-assisted victim assessment places a robot approximately three meters or less from a victim, and the path of the robot traverses three proximity zones: intimate, personal, and social. The victim's-eye views of the robot from seven points of interest on the path illustrate the appropriateness of each of the five primary non-facial/non-verbal methods of affective expression: (body movement, posture, orientation, illuminated color, and sound), offering support for the heuristics as a design aid.

On-Line Behaviour Classification and Adaptation to Human-Robot Interaction Styles
Dorothée François, Daniel Polani and Kerstin Dautenhahn

This paper presents a proof-of-concept of a robot that adapts its behavior on-line, during interactions with a human according to detected play styles. The study is part of the AuRoRa project, which is investigating how robots may be used to help children with autism overcome some of their impairments in social interactions. The paper motivates why adaptation is a very desirable feature of autonomous robots in human-robot interaction scenarios in general, and in autism therapy in particular. Two different play styles namely strong and gentle, which refer to the user, are investigated experimentally. First experiments were carried out which discuss the performance of the model and related work on adaptation in socially assistive and therapeutic work are surveyed.

Realizing Hinokio: Candidate Requirements for Physical Avatar Systems
Laurel D. Riek

This paper presents a set of candidate requirements and survey questions for physical avatar systems as derived from the literature. These requirements will be applied to analyze a fictional, yet well-envisioned, physical avatar system depicted in the film Hinokio. It is hoped that other researchers can use these requirements and survey questions as a guide when performing formal engineering tradeoff analysis during the design phase of new physical avatar systems, or during evaluation of existing systems.

Robot Expressionism Through Cartooning
James E. Young, Min Xin, and Ehud Sharlin

We present a new technique for HRI called robot expressionism through cartooning. We suggest that robots utilize cartoon-art techniques such as simplified and exaggerated facial expressions, stylized text, and icons for intuitive social interaction with humans. We discuss practical mixed reality solutions that allow robots to augment themselves or their surroundings with cartoon art content. This paper discusses a variety of ways that allow robots to use cartoon art and details a test bed design, implementation, and exploratory evaluation.

Robotic Etiquette: Results From User Studies Involving a Fetch and Carry Task
Michael L. Walters, Kerstin Dautenhahn, Sarah N. Woods, Kheng Lee Koay

This paper presents results, outcomes and conclusions from a series of HRI trials that investigated how a robot should approach a human in a fetch and carry task. In general, seated humans do not like to be approached by a robot directly from the front even when seated behind a table. A frontal approach is more acceptable when a human is standing in an open area. Subjects do not usually like the robot to move or approach from directly behind them, preferring the robot to be in view even if this means the robot taking a physically non-optimum path. Future research aims are outlined and include the necessity of carrying out longitudinal trials to see if these findings hold over a longer period of exposure to robots.

Robots as Interfaces to Haptic and Locomotor Spaces
Vladimir Kulyukin, Chaitanya Gharpure, and Cassidy Pentico

Research on spatial cognition and navigation of the visually impaired suggests that vision may be a primary sensory modality that enables humans to align the egocentric and allocentric frames of reference in space. In this paper, we argue that robots can function as interfaces to the haptic and locomotor spaces in supermarkets. We present a trichotomous ontology of spaces in a supermarket induced by the presence of a robotic shopping assistant and analyze the results of robot-assisted shopping with visually impaired participants in a real supermarket.

The RUBI Project: a Progress Report
J. R. Movellan, F. Tanaka, I. R. Fasel, C. Taylor, P. Ruvolo, and M. Eckhardt

The goal of the RUBI project is to accelerate progress in the development of social robots by addressing the problem at multiple levels. The RUBI project emphasizes the process of "design by immersion", i.e., embedding scientists, engineers and robots in everyday life environments so as to have these environments shape the hardware, software, and scientific questions as early as possible in the development process. In this paper, we present an overall assessment of the lessons and progress by the end of the project's second year.

Spatial Dialogue for Space System Autonomy
Scott Green, Scott Richardson, Vadim Slavin, and Randy Stiles

Future space operations will increasingly demand cooperation between humans and autonomous space systems such as robots, observer satellites, and distributed components. Visual spatial information is a common reference for increased shared situation awareness between humans and autonomous systems. With this in mind, we have created a prototype spatial dialog system to support teamwork between humans and autonomous robotic agents. This paper describes our approach and issues for team-oriented spatial dialog interaction.

Speed Adaptation for a Robot Walking With a Human
Emma Sviestins, Noriaki Mitsunaga, Takayuki Kanda, Hiroshi Ishiguro and Norihiro Hagita

We have taken steps towards developing a method that enables an interactive humanoid robot to adapt its speed to a walking human. From a case study in human-human walking interaction we established a hypothesis about how to read a human's speed preference is based on a relationship between humans' walking speed and their relative position in the direction of walking. We conducted two experiments to verify this hypothesis: one with two humans walking together, and one with a human subject walking with a humanoid robot, Robovie-IV.

Young Researchers' Views on the Current and Future State of HRI
Kevin Gold, Ian Fasel, Nathan G. Freier, and Cristen Torrey

This paper presents the results of a panel on "The Future of HRI" at an NSF workshop. In general, the participants shared the belief that HRI can and should be seen as a single science, despite the fact that it encompasses a variety of beliefs, methods, and philosophies drawn from several "core" disciplines. HRI researchers share many goals and enhancing communication between different areas would help speed up progress. Common concerns included the unavailability of common platforms, emphasis on human perception, and the paucity of longitudinal studies.

Tracking Human Motion and Actions for Interactive Robots
Odest Chadwicke Jenkins, German Gonzalez, Matthew Maverick Loper

A method is presented for kinematic pose estimation and action recognition from monocular robot vision through the use of dynamical human motion vocabularies. We propose using dynamical motion vocabularies to bridge the decision making of observed humans and information from robot sensing. The efficacy of our approach is demonstrated through tracking and action recognition over extended motion trials. Results evidence the robustness of the algorithm with respect to unsegmented multi-action movement, movement speed, and camera viewpoint.

User-Centered Approach to Path Planning of Cleaning Robots: Analyzing User's Cleaning Behavior
Hyunjin Kim, Hyunjeong Lee, Stanley Chung, and Changsu Kim

In this paper, we have analyzed the cleaning behaviors in home environments and understood the user's path planning behaviors through usage tests of various vacuuming robots. We discovered that the actual user cleans with methods unique to specific areas of the house rather than following an optimal cleaning path. We not only suggest a path planning method for the vacuuming robot by using a layered map, but also a cleaning area designating method reflecting each areas characteristics. Based on these, we have designed a vacuuming robot's actions.

Conference Design

The Human-Robot Interaction (HRI) Conference is a highly selective, single track conference that showcases the best research in human-robot interaction each year. HRI brings together researchers from many domains, emphasizes interdisciplinary work, and is co-sponsored by ACM and IEEE. Here are the design criteria for HRI:

Excellence. HRI is intended to be the top conference in human-robot interaction. To achieve this goal, we collect three (or more) high-quality, anonymous, peer reviews per submission. Reviews are released early to authors, who may provide a rebuttal to correct misconceptions and address errors. The program committee meets in person to discuss all submissions and selects only the very best papers. All acceptances are provisional and revisions are reviewed prior to publication.

Merit-based selection. Papers are selected based purely on merit and impact to the field of HRI, regardless whether the author is well-known to the community or a newcomer, a senior scientist or first-year graduate student. Since HRI is a young field, research topics evolve rapidly and what constitutes an important contribution varies. A significant paper might contribute new theory, new empirical observations, a new method (or application of a method from another discipline), or a creative way of thinking about HRI.

International. Research in human-robot interaction is not limited to specific institutions or geographic regions. Thus, the conference explicitly solicits submissions and participation from researchers worldwide. Although first two HRI conferences were held in the United States, HRI 2008 will take place in Europe, and HRI 2009 will be located in the Pacific Rim.

Multi-disciplinary. HRI is a multi-disciplinary field and includes researchers working in engineering (computer science, mechanical engineering, robotics), cognitive science, social sciences, and design. Thus, the selection of program committee and reviewers emphasizes individuals who: represent a broad range of disciplines, perform inter-disciplinary research, and are motivated to evaluate work from different disciplines by the standards of those disciplines.

Affordable. In order to help the participants, the community, and the field to grow, HRI aims to keep costs low. Location, facilities, and registration fees are chosen in order to minimize costs as much as possible. For this reason, HRI does not meet in places that are time-consuming or difficult to reach, nor select conference sites that are expensive. We believe that affordability is essential to enabling students to participate.

Interactive and inclusive. To insure that we promote creative inquiry, HRI is designed to include many points of view and discussion. To promote community-wide discussion and learning, HRI is planned as single-track. Oral presentations are given sufficient time for detailed questions. Poster sessions are arranged so that people can spend significant time with authors. Panels emphasize debate and discussion (rather than dry presentations). Keynote speakers are chosen based on their ability to engage and spark interest.

Sustainable. HRI is structured to be sustainable over the long-term. The steering committee is composed of a small group of standing members, plus the general and program chairs from the past year, the current year, and the upcoming year. This allows the organization to evolve quickly and to ensure the continuous infusion of new talent into the conference. In addition, we work very closely with both ACM and IEEE to guarantee that banking, insurance, publication, and promotion are handled efficiently and professionally.

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2008 ACM/IEEE International Conference on Human-Robot Interaction (HRI 2008)

12-15 March 2008, Amsterdam, the Netherlands
http://www.hri2008.org hri2008@hri2008.org

Living With Robots

Today's robots require human-robot interaction (HRI) capabilities designed for the increasing variety of environments and contexts in which they operate. Teleoperation techniques are important in domains such as search-and-rescue, military operations, and space exploration, whereas human-like communications capabilities are necessary for robots operating in everyday settings such as home, office, shopping, and museum environments. In both cases, HRI is essential in enabling robots to transcend the role of mere tools and begin to collaborate with humans to accomplish complex tasks. The Third Annual Conference on Human-Robot Interaction is dedicated to these and other issues in HRI. The theme of HRI 2008, **"Living With Robots"**, highlights the importance of the technical and social issues underlying long-term human-robot interaction towards companion and assistive robots for long-term use in everyday life and work activities. HRI is a single-track, highly selective annual conference that seeks to showcase the very best interdisciplinary and multidisciplinary research in human-robot interaction with roots in psychology, cognitive science, HCI, human factors, artificial intelligence and robotics, and we invite broad participation.

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Full and Short Paper Submission

Authors are invited to submit manuscripts in PDF (Adobe Acrobat) format for full and short papers. Eight camera-ready pages including figures are allowed for each full paper. Accepted full papers will be published in the conference proceedings, archived in the ACM Digital Library, and assigned for either oral or full poster presentation. Authors are also encouraged to submit their late-breaking results for short papers. Two pages are allowed for each short paper. Accepted short papers will be assigned for short poster presentation, but will not be published in the conference proceedings. Detailed instructions are available on the conference web site: http://www.hri2008.org.

Video Submission

We invite videos related to all aspects of HRI. Besides the importance of the lessons learned and the novelty of the situation, the entertainment value will be judged. The video itself must be self-explanatory for the audience. The videos will be published in the conference proceedings and archived in the ACM Digital Library.

Tutorials and Workshops

Proposals are sought from those wishing to organize a Tutorial or a Workshop on a HRI-related theme. Tutorials and Workshops will be held on March 12, one day before the main technical sessions.

Exhibitions

There will be an exhibition site at the conference and promoters are encouraged to display state-of-the-art products and services in all areas of robotics and human-robot interaction.

Suggested Topics

Socially intelligent robots	User studies of HRI
Robot companions	Experiments on HRI collaboration
Lifelike robots	Ethnography and field studies
Assistive (health & personal care) robotics	HRI software architectures
Remote robots	HRI foundations
Mixed initiative interaction	Metrics for teamwork
Multi-modal interaction	HRI group dynamics
Long-term interaction with robots	Individual vs. group HRI
Awareness and monitoring of humans	Robot intermediaries
Task allocation and coordination	Risks such as privacy or safety
Autonomy and trust	Ethical issues of HRI
Robot-team learning	Organizational/society impact

Important Dates

10 September 2007	Submission of papers, videos, and tutorial/workshop proposals
12-16 November 2007	Rebuttal period
7 December 2007	Notification of acceptance
11 January 2008	Final camera-ready papers due

(pending) *(pending)*