ICRA

40

40th Anniversary of the IEEE Conference on Robotics & Automation (ICRA@40)

23–26 September, 2024

Rotterdam, Netherlands

Welcome to ICRA@40!

Esteemed researchers, distinguished guests, and passionate enthusiasts of robotics and automation, we are thrilled to welcome you to a special symposium commemorating 40 years of the founding of the IEEE Robotics and Automation Society (RAS) and the launch of ICRA, the largest conference in robotics. This landmark event, ICRA@40, marks a significant milestone in the history of robotics as an intellectual discipline, offering a unique format that promises to be a historic gathering.

For four days, we will embark on a journey through the evolution of robotics and automation, from its early days as a subfield of disparate fields to its current incarnation as a rich intellectual discipline in its own right. The event is structured into eight half-day plenary sessions, each featuring a series of prestigious keynotes covering the core topics of our field. From the design and control of robots to the latest advancements in AI tools and materials, our speakers will explore the innovations that have shaped our past and the technologies that will define our future.

ICRA@40 is not just a celebration; it is a platform for reflection and debate. We invite all attendees to engage in numerous panels and discussions on crucial issues, such as the societal impact and ethical implications of robotics and automation, the growing role of AI in our field, and its industrial and societal significance. These sessions are designed to provoke thought, inspire dialogue, and foster a deeper understanding of our shared challenges and opportunities.

We are proud to provide a stage for practitioners from well-established industries to dynamic start-ups, offering industry pitches that showcase successful use cases and highlight open problems for the future. This interaction between academia and industry is a cornerstone of ICRA@40, ensuring a comprehensive view of the field's current state and future direction.

Networking and dissemination are at the heart of ICRA@40. We have curated multiple opportunities for attendees to connect, including interactive panels and debates, luncheons arenas, demos, and numerous social events. These events are designed to foster meaningful connections and collaborative opportunities.

During the four days of the ICRA@40 conference, we look forward to a comprehensive scientific program, featuring talks by 83 distinguished speakers, 14 industry pitches, four debates and, of course, the interactive sessions contributed by the world-wide robotics community. We are glad for almost 2000 authors having teamed up to create around 500 submissions, coming from over 40 countries on all populated continents. With the travel grants for underrepresented groups, we have taken action to foster equal opportunities in the field of robotics, and hope for a continuously more balanced global participation in the future. Among the submissions are 161 journal publications to be presented at ICRA@40. Having particularly encouraged to submit videos, we especially value the 47 stand-alone video submissions, and 236 accompanying videos. Viewing just these would already give you more than 9 hours of continuous streaming of exciting videos on robotics – watching them on your travel has the potential to significantly shorten the perceived duration of your journey.

Welcome to ICRA@40. Let us celebrate the past, inspire the present, and shape the future of robotics and automation together.

Stefano Stramigioli
General Chair

Frank Park
General Co-Chair

Tamim Asfour
Program Chair

Aude Billard
IEEE RAS President

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Organization Committee

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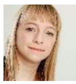

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University of Bristol

Terence Martinez
Operation Team
IEEE Robotics and Automation Society

Amy Reeder
Operation Team
IEEE Robotics and Automation Society

Lukrecija LeLong
Operation Team
IEEE Meetings, Conferences & Events (MCE)

Distinguished Speakers

Arash Ajoudani
Italian Institute of Technology

Alin Albu-Schäffer
DLR – German Aerospace Center

Yiannis Aloimonos
University of Maryland

Fumihito Arai
The University of Tokyo

Sven Behnke
University of Bonn

Antonio Bicchi
IIT

Ruzena Bajcsy
University of Pennsylvania

Cynthia Breazeal
MIT

Darius Burschka
Technische Universität München

Oliver Brock
Technische Universität Berlin

Wolfram Burgard
University of Technology Nuremberg

Jessica Burgner-Kahrs
University of Toronto

Alicia Casals
Universitat Politècnica de Catalunya & RobSurgicalSystems

Georgia Chalvatzaki
TU Darmstadt

Raja Chatila
Sorbonne University

Gordon Cheng
Technical University of Munich (TUM)

Kyujin Cho
SNU

Soon-Jo Chung
Caltech

Peter Corke
Queensland University

Kostas Daniilidis
University of Pennsylvania

Paolo Dario
The BioRobotics Institute, Scuola Superiore Sant'Anna, Pisa

Kerstin Dautenhahn
University of Waterloo

Alessandro De Luca
Sapienza University of Rome

Elena De Momi
Politecnico di Milano

Ruediger Dillmann
KIT

Dario Floreano
EPFL

Dieter Fox
University of Washington / NVIDIA

Antonio Franchi
Univ. Twente and Sapienza Univ. Rome

Maria Gini
University of Minnesota

Ken Goldberg
UC Berkeley

Yi Guo
Stevens Institute of Technology

Gregory Hager
John Hopkins University

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University of Utah

Josie Hughes
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Lydia Kavraki
Rice University

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Stanford University

Abderrahmane Kheddar
CNRS-AIST JRL, Japan and CNRS-UM LIRMM, France

Sangbae Kim
MIT

Jens Kober
TU Delft

Jana Kosecka
George Mason University

Katherine J. Kuchenbecker
Max Planck Institute for Intelligent Systems

James Kuffner
Toyota Motor Corporation

Yasuo Kuniyoshi
The University of Tokyo

Dong-Soo Kwon
KAIST/ROEN Surgical

Steven LaValle
University of Oulu

Dongheui Lee
TU Wien

Zexiang Li
Hong Kong University of Science and Technology

Kevin Lynch
Northwestern University

Matthew Mason
Carnegie Mellon University and Berkshire Grey

Fumitoshi Matsuno
Osaka Institute of Technology

Barbara Mazzolai
Istituto Italiano di Tecnologia

Giorgio Metta
Istituto Italiano di Tecnologia

Yukie Nagai
The University of Tokyo

Yoshihiko Nakamura
Mohamed bin Zayed University of Artificial Intelligence

Bradley Nelson
ETH ZURICH

Marcia O'Malley
Rice University

Allison Okamura
Stanford University

Anibal Ollero
Universidad de Sevilla and CATEC Aerospace Technology Center

Marco Pavone
Stanford University and NVIDIA

Jan Peters
TU Darmstadt & DFKI

Domenico Prattichizzo
University of Siena and Istituto Italiano di Tecnologia

Marc Raibert
The AI Institute

Karinne Ramirez-Amaro
Chalmers University of Technology

Ludovic Righetti
New York University

Nicholas Roy
MIT

Daniela Rus
CSAIL / MIT

Giulio Sandini
Istituto Italiano di Tecnologia

Davide Scaramuzza
University of Zurich

Brian Scassellati
Yale University

Bruno Siciliano
University of Naples Federico II

Roland Siegwart
ETH ZURICH

Jean-Jacques Slotine
MIT

Kenji Suzuki
University of Tsukuba, Japan

Satoshi Tadokoro
Tohoku University

Atsuo Takanishi
Waseda University

Carme Torras
Institut de Robòtica i Informàtica Industrial, CSIC-UPC

Heike Vallery
RWTH Aachen

Vincent Vanhoucke
Waymo

Manuela Veloso
JPMorganChase & CMU

Birgit Vogel-Heuser
Technical University of Munich (TUM)

Michael Yu Wang
Great Bay University

Jing Xiao
WPI

Eiichi Yoshida
Tokyo University of Science

Venue

General information

The Netherlands is a small country with one of the most technologically driven economies in the world. Originating in our need to keep our feet dry and our cities thriving – innovation and international collaboration has always played an important role in who we are. Today, the Netherlands is a creative and inclusive country that looks towards the future and beyond its own boundaries.

Rotterdam's excellent connections, including Schiphol and Rotterdam airports within 24 minutes, as well as high-speed rail (Thalys, Eurostar, ICE), make it easily accessible for event attendees. As Europe's leading port and a global industrial hub, Rotterdam offers a vibrant and productive environment for international companies.

Important locations for the conference

ICRA@40 takes place at *Rotterdam Ahoy*, located in the south-central of the city. Ahoy is easily accessible by bus, metro, and train: *Accessibility*. From the *Zuidplein* bus and metro station, it's just a 5-minute walk to Ahoy! Plan your journey using the trip planners of *NS*, *RET*, or *9292*. You can pay by checking in and out with an *OV-chipkaart* (Dutch public transport card) or your bank's contactless debit or credit card (*OVpay*). You can buy an anonymous *OV-chipkaart* at any large train station (Tip: pick one up at Schiphol airport upon arrival). You can also still buy single-use (e)tickets, which may cost you a little extra.

The **Happy Birthday ICRA Party** takes place at the Holland America Line Cruise Terminal, also known as *Cruise Terminal Rotterdam*. This industrial heritage building, now modernised, was the departure point of the Holland America line that transported many migrants to New York from 1873 to 1978. The terminal is situated on the *Rotterdamse Wilhelminapier*. The easiest way to reach the pier is through the metro from *Zuidplein*, D train towards Rotterdam Centraal or E train towards Den Haag Centraal, leaving every 8 minutes, taking exit *Wilhelminaplein*.

The **VIP Dinner** (invite only) takes place at the *Sint-Laurenskerk*. The only remnant of the medieval city of Rotterdam, this restored late Gothic church (first finished 1525) offers a beautiful atmosphere for this small-scale dinner. It is easily reached with the metro line from *Zuidplein*, D train towards Rotterdam Centraal or E train towards Den Haag Centraal, taking exit *Beurs*, followed by a short 8-minute walk.

Program

To get a brief overview of the program, one-pagers are provided further below for the overall program and the keynotes. Detailed information on each interactive session is provided via *papercept*, as individually linked in the following schedules of each day.

Monday, September 23

09:00 – 09:15	**Welcome**
09:10 – 10:30	**Keynote Session 1**
	Yasuo Kuniyoshi *From Embodiment to Super-Embodiment: An Approach to Open-Ended and Human Aligned Intelligence/Mind*
	Atsuo Takanishi *Bipedal Walking Robot Developments in The Early Days, 1960s to 1980s, in Japan*
	Sangbae Kim *Physical intelligence and Cognitive Biases Toward AI*
	Alícia Casals *Redundancy in multi-arm platforms — A trade-off for its usability in surgical robotics*
	Sven Behnke *Towards Conscious Service Robots*
	Kerstin Dautenhahn *Complexities of a Co-Design Approach to Developing Social Robots for Real World Applications*
	Ken Goldberg *Is Data All You Need?* *Large Robot Action Models and Good Old Fashioned Engineering*
10:30 – 11:00	**Coffee Break**

11:00 – 12:30	**Keynote Session 2**	
	Jan Peters *Inductive Biases for Robot Learning*	
	Davide Scaramuzza *Agile Robotics: from Cameras to Neuromorphic Sensors*	
	Yukie Nagai *Embodied Predictive Processing: New Horizons in Cognitive Developmental Robotics*	
	Rüdiger Dillmann *Learning of Robot Behaviour and Skills from Human Task Demonstration and Activity Observation*	
	Dongheui Lee *Human-Centric Approaches for Robot Learning and Interaction with Human*	
	Karinne Ramirez-Amaro *Learning the How and Why from Experience: Combining Interpretable and Explainable Methods in Robot Decision-Making*	
	Fumitoshi Matsuno *Beyond Living Things – Bio-inspired robots and disaster response robotics*	
12:30 – 13:15	**Interactive Session 1** *See* papercept / MoINT1S *for details*	
13:15 – 14:15	**Lunch Break**	

14:15 – 15:00 **Interactive Session 2**

See *papercept / MoINT2S* for details

15:00 – 16:30 **Keynote Session 3**

Ruzena Bajcsy
Robotics at the University of Pennsylvania from Birth to Maturity: A Review of 30 Years of Research

Matthew Mason
Lessons from Warehouse Robotics: From Warehouses to Kitchens

Peter Corke
The Robotics Toolbox – 30 years old and still going strong

Lydia Kavraki
30 Years of Sampling-based Motion Planners: from Minutes to Microseconds

Roland Siegwart
Flying Robots – From Basic Flight Capabilities to Autonomous Navigation and In-flight Physical Interactions

Oussama Khatib
The Journey of Robotics

16:30 – 17:00 **Coffee Break**

17:00 – 17:30 **Industry Pitches 1**

PAL Robotics
Francesco Ferro

Asimovo
Christine Fraser

euRobotics
Reinhard Lafrenz

17:30 – 18:30	**Debate & Panel 1** **Progress We Have Made** *What progress has been made in different areas of robotics and automation over the past decades, and what key challenges remain?*
	Ken Goldberg (Chair) Peter Corke Lydia Kavraki Oussama Khatib Dong-Soo Kwon Allison Okamura Matt Mason Jan Peters Roland Siegwart Atsuo Takanishi
18:30 – 20:30	**Welcome Reception**

Tuesday, September 24

09:00 – 10:30	**Keynote Session 4**
	Katherine J. Kuchenbecker *Haptic Intelligence*
	Allison Okamura *Wearable Haptic Devices for Ubiquitous Communication*
	Domenico Prattichizzo *Wearable Haptics: From Robotics to Potential Cancer Treatments*
	Dieter Fox *Where is RobotGPT?*
	Kostas Daniilidis *Efficient Robot Perception Through Symmetry, Active Sensing, and Event-Vision*
	Gregory Hager *Toward Flexible Vision-Enabled System for the Physical World: Are We There Yet?*
	Jana Kosecka *Finding Objects in the Era of Large Vision and Language Models*
10:30 – 11:00	**Coffee Break**

11:00 – 12:30	**Keynote Session 5**	
	Bradley Nelson *The Robotics Part of Micro and Nano Robots*	
	Fumihito Arai *Micro and Nano Robotics – Manipulation and Automation at Small Scales in Biomedical Field*	
	Nicholas Roy *Hierarchy, Abstractions and Geometry*	
	Gordon Cheng *Tactile Intelligence for Robots*	
	Giulio Sandini *From Active Vision to iCub and the Elusive Quest for Cognition*	
	Elena De Momi *Autonomy in robotic surgery – from the bench to the bedside*	
	Kyujin Cho *Soft Wearable Robots: Creating Technology to Enhance Human Capabilities*	
	Birgit Vogel-Heuser *Field-level automation architectures: A key challenge for adaptable, self-healing production systems*	
12:30 – 13:15	**Interactive Session 3** See *papercept / TuINT1S* for details	
13:15 – 14:15	**Lunch Break**	

14:15 – 15:00 **Interactive Session 4**

See *papercept / TuINT2S* for details

15:00 – 16:30 **Keynote Session 6**

Manuela Veloso
Towards a Seamless Integration of Humans and Mobile Task Robots

James Kuffner
Building Safe Intelligent Machines

Yoshihiko Nakamura
Will Humanoid and AI Show a Vista of the Intelligence?

Vincent Vanhoucke
Constitutional Embodied AI

Daniela Rus
Physical Intelligence

Yiannis Aloimonos
Embodied, Perceptually Grounded Robotics

Oliver Brock
Intelligence: Artificial, Biological, Embodied

16:30 – 17:00 **Coffee Break**

17:00 – 17:30 **Industry Pitches 2**

Vrije Universiteit Brussel
Bram Vanderborght

Boskalis
Sebastian Henrion, Harold van Heukelum

SPRINT Robotics
Niels Westendorp

17:30 – 18:30

Debate & Panel 2
Robot Intelligence

What progress has been made towards true robot intelligence, how robotics can contribute to understanding fundamental challenges in AI, and how interdisciplinary research can accelerate progress in the field?

Oliver Brock (Chair)
Yiannis Aloimonos
Wolfram Burgard
James Kuffner
Yasuo Kuniyoshi
Daniela Rus
Giulio Sandini
Brian Scassellati
Vincent Vanhoucke
Manuela Veloso

Wednesday, September 25

09:00 – 10:30	**Keynote Session 7**	
	Satoshi Tadokoro *Rescue Robotics Challenge for 2050*	
	Raja Chatila *The “Intelligent Connection of Perception to Action”*	
	Antonio Bicchi *Learning from Humans How to Manipulate with Compliant, Underactuated, and Environment-driven hands*	
	Carme Torras *Robotics in healthcare – Closing the reality gap through co-design and technoethics education*	
	Giorgio Metta *Building Components of Human-Robot Interaction on the iCub Humanoid Robot*	
	Yi Guo *Bridging Model-Based and Learning-Based Control Methods for Autonomous Mobile Robotic Systems*	
	Bruno Siciliano *A Revolutionary Theranostics Approach for Robotized Colonoscopy*	
10:30 – 11:00	**Coffee Break**	

11:00 – 12:30	**Keynote Session 8**	
	Paolo Dario *Biorobotics and Bionics: from Dream to Reality*	
	Wolfram Burgard *Probabilistic and Deep Learning Techniques for Robot Navigation and Automated Driving*	
	Brian Scassellati *Robots that Support Human Cognitive and Social Skills*	
	Jens Kober *Robots Learning Through Interactions*	
	Cynthia Breazeal *Social Robots: Reflections and Predictions of Our Future Relationship with Personal Robots*	
	Robotics Medal and Rising Star Award	
12:30 – 13:15	**Interactive Session 5** See *papercept / WeINT1S* for details	
13:15 – 14:15	**Lunch Break**	

14:15 – 15:00	**Interactive Session 6** See *papercept / WeINT2S* for details
15:00 – 16:30	**Keynote Session 9**
	Darius Burschka *Understanding of Motion in Static and Dynamic Environments from Monocular Video Streams - Evolution of Optical Flow Research in Robotics*
	Alessandro De Luca *Safe Control of Physical Human-Robot Interaction*
	Jean-Jacques Slotine *Stable Adaptation and Learning*
	Alin Albu-Schäffer *The Journey of Embodied Intelligence and Energy-aware Control*
	Arash Ajoudani *Autonomous and Human-Collaborative Mobile Manipulation through Hybrid Learning and Control*
	Ludovic Righetti *Is Locomotion a Solved Algorithmic Problem?*
	Marc Raibert *We've come a long way, and still have a way to go.*
16:30 – 17:00	**Coffee Break**

17:00 – 17:30	**Industry Pitches 3**
	Roboception *Michael Suppa*
	PULSAR HRI *Miguel López*
	Dutch Authority for Digital Infrastructure (RDI) *Huub Janssen*
	Haption *Jean-François de Sallier*
17:30 – 18:30	**Debate & Panel 3** Robotics Research and Government *What are common challenges and goals faced by government-funded institutions with large-scale robotics programs, and how can collaboration with the robotics research community and private industry be implemented?*
	Alin Albu-Schäffer (Chair) Rainer Bischoff Gregory Hager Giorgio Metta Sangrok Oh Marc Raibert Representative of ADRA
19:30 – 22:30	**Happy Birthday ICRA**

Thursday, September 26

09:00 – 10:30	**Keynote Session 10**
	Dong-Soo Kwon *Robotic Ureteroscopy System: from Research to Commercialization*
	Kevin Lynch *Chasing Dexterity: Autonomous and Human-Collaborative Robot Manipulation*
	Michael Yu Wang *Robot Manipulation Skill Learning and Engineering*
	Jing Xiao *Robotic Perception-Action Synergy in Unknown and Uncertain Environments*
	Maria Gini *The many facets of allocation of tasks to robots*
	Thomas C. Henderson *Safe UAS Traffic Management in the Context of Urban Air Mobility*
	Abderrahmane Kheddar *Are Humanoids Ready for the Job?*
	Eiichi Yoshida *Unified Data-Driven Anthropomorphic Contact-Rich Motion Synthesis*
10:30 – 11:00	**Coffee Break**

11:00 – 12:30	**Keynote Session 11**	
	Steven LaValle *Planning Algorithms: Past, Present, and Possible Future*	
	Zexiang Li *From Robotics competition to education innovation and startups*	
	Dario Floreano *From flying animals to drones and back*	
	Anibal Ollero *Toward Bioinspired and Soft Aerial Robotics*	
	Soon-Jo Chung *Learning and Decision Making for Fast Robots under Failures*	
	Antonio Franchi *Aerial Robotics: Lessons Learned and Future Directions in Modelling and Control*	
	Marco Pavone *Rethinking AV Development with AV Foundation Models*	
	Georgia Chalvatzaki *Mobile Manipulation Skills & Why We Need Them*	
12:30 – 13:15	**Interactive Session 7** See *papercept / ThInt1S* for details	
13:15 – 14:15	**Lunch Break**	

14:15 – 15:00	**Interactive Session 8** See *papercept / ThINT2S* for details	
15:00 – 16:30	**Keynote Session 12**	
	Barbara Mazzolai *EcoRobots: Soft Machines for Sustainable Environmental Applications*	
	Marcia O'Malley *Haptics – Augmenting Human Performance with Touch Feedback*	
	Jessica Burgner-Kahrs *Open Continuum Robotics*	
	Josie Hughes *Towards Robust Robots by Building Embodied Intelligence*	
	Kenji Suzuki *Advancing Human Capabilities from Assistive Robotics to Wearable Cyborgs*	
	Heike Vallery *Paradigm Shifts and Technological Enablers in Rehabilitation Robotics*	
16:30 – 17:00	**Coffee Break**	

17:00 – 17:30	**Industry Pitches 4**
	University of Twente Robotics Centre *Steven van Roon*
	Avular *Tess Kolkman*
	Xsens | Movella *Gijs Heutink*
	WaveHexaPod *Johan Paulides*
17:30 – 18:30	**Debate & Panel 4** Ethics and Responsibility in Robotics *What is the role of ethical considerations in the development and deployment of robotic and automation technologies and what are the responsibilities of researchers to ensure that these technologies advance in ways that are transparent, fair, and aligned with the broader well-being of society?*
	Ludovic Righetti (Chair) Nancy Amato Thomas C. Henderson Kevin Lynch Barbara Mazzolai Yoshihiko Nakamura Kenji Suzuki Patrick van der Smagt
18:30 – 20:00	**Farewell Reception**

Interactive Sessions

Twice a day, the interactive sessions provide the opportunity to talk in-depth with other members of the robotics community about the work they present at digital screens. If you are a presenter yourself, ensure to be aware of the instructions below.

Instructions for Presenters

All accepted contributions, including

- Papers transferred from journals
- Extended abstracts
- Stand-alone videos

will be presented in Interactive Sessions.

If you are a presenter, you will be provided with an LCD screen equipped with an HDMI interface to which you can connect to present your work. You must bring your own laptop to display slides/videos or other material related to your work.

For your presentation, you should prepare a set of slides that explain your work and that you can use for discussion with participants visiting your booth.

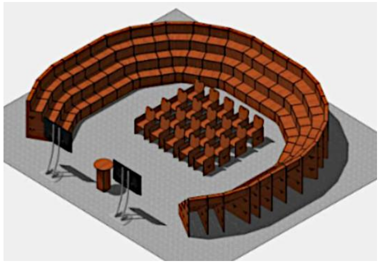
Do not print paper posters, as there will be no room for them.

Check the *program on papercept* to see which interactive session you will be presenting in. The number of your paper in the program indicates also the LCD screen you should use during the interactive session.

Arena Lunches and Debates

The Interactive Lunch Sessions at the ICRA@40 conference provide a unique platform for engaging with leading figures in academia and industry. Each session is designed to foster dynamic discussions and debates on the latest trends and innovations in robotics and automation.

Session Format



- Duration: 1 hour per day
- 80 participants per session **(first come first served)**
- Setup: Arena-style seating for enhanced interaction
- Moderator to guide discussions and maintain engagement

There will be two speakers per session with contrasting work/ideas. They will have a few minutes to present the topic using a demonstrator or a representative video. **Speakers end their talks with a provocative question or statement to spark immediate reactions and set the tone for the debate.** The moderator opens the floor for debate with the audience. The debate happens between the audience and the speakers:

- 13:15 – 13:20: Welcome and Introduction by Moderator
- 13:20 – 13:30: Speaker 1 – Presentation and Pitch
- 13:30 – 13:40: Speaker 2 – Presentation and Pitch
- 13:40 – 14:15: Open Debate and Q&A Session

Topics

Each day, you can meet inspiring people from a different field:

- Monday, September 23: Academic Leaders
- Tuesday, September 24: Innovators
- Wednesday, September 25: Rising Stars
- Thursday, September 26: Industry Experts

Monday, September 23	**Arena Lunch & Debate with Academic Leaders** Bridging Minds and Machines: Advancing Trust and Human Features in Robotics and Automation
	Teaching humans to rely on robots Lorenzo Masia, Heidelberg University *Exploring how to design and develop robots that seamlessly integrate into human environments, encouraging users to trust and depend on robotic assistance for various tasks.* **Teaching robots to mimic humans** Donghuei Lee, TU Wien *Exploring how endowing robots with human-like traits can transform robotic performances, pushing the boundaries of what robots can achieve in daily settings.* Moderation: *Enrica Tricomi (Heidelberg University) and* *Federico Masiero (Heidelberg University)*
Tuesday, September 24	**Arena Lunch & Debate with Innovators** From Vision to Reality: Addressing the Real-World Challenges in Robotics Innovation
	Envisioning Tomorrow: The Bold Future of Robotics and Its Potential Mohan Rajesh Elara, Singapore University of Technology and Design *Exploring the transformative visions for the future of robotics, focusing on cutting-edge technologies and speculative advancements.* **Reality Check: Overcoming Practical Barriers in Robotics Innovation** Torsten Kröger, Intrinsic *Exploring practical challenges encountered by innovators in turning their concepts into viable products.* Moderation: *Enrica Tricomi (Heidelberg University),* *Khurana Harshit (EPFL)*

Wednesday, September 25	**Arena Lunch & Debate with Rising Stars** Pioneering Robotics and Automation: Fresh Perspectives on the Next Robotics Generation
	Fresh perspective on Next-Gen Robotics Amy Han, SNU *Presenting groundbreaking ideas and innovative approaches that emerging researchers are bringing to the field of robotics.* **Challenges on Next-Gen Robotics** Majid Khadiv, TUM *Contemporary challenges facing robotics research, offering insights into the practical issues encountered in the field.* Moderation: *Enrica Tricomi (Heidelberg University),* *Gholami Soheil (EPFL)*
Thursday, September 26	**Arena Lunch & Debate with Industry Experts** Is AI Truly Redefining Robotics?
	AI Innovations in Robotics: Redefining Capabilities and Applications Vincent Vanhoucke, Waymo *How advancements in AI are pushing the boundaries of robotics, enabling new capabilities and applications.* **AI Limitations in Robotics: Challenges in Integration and performance** Christine Fraser, CEO of Asimovo *Exploring the limitations and challenges of integrating AI into robotics, including issues related to reliability, ethical concerns, and the practical difficulties of implementing AI solutions in real-world robotic systems.* Moderation: *Enrica Tricomi (Heidelberg University),* *Francesco Missiroli (Heidelberg University)*

RAS Events at ICRA@40

RAS offers three special events around lunch time at ICRA@40, each taking place from 13:15 – 14:15 at Dock 10 AB.

Tuesday, September 24	**RAS-WiE Lunch** Women shaping the future of robotics and automation *Join RAS Women in Engineering for an interactive panel discussion and networking over lunch. Meet the Inclusion, Diversity, Equity & Accessibility Awardees attending ICRA@40!* *The goal for this event is to be more than a luncheon with women. All are encouraged to participate and enjoy the discussion.*
Wednesday, September 25	**IEEE Young Professionals Luncheon** Empowering the Next Generation *Join us for a dynamic and engaging luncheon designed to empower the next generation of leaders in technology and engineering. This event provides a unique opportunity for IEEE Young Professionals to network with peers, industry experts, and thought leaders. Attendees will gain valuable insights into career development, emerging technologies, and strategies for professional growth. Enjoy a delicious meal while participating in interactive discussions and activities aimed at fostering innovation and collaboration. Don't miss this chance to build connections, share experiences, and be inspired to take your career to the next level.*
Thursday, September 26	**RAS Lunch with Leaders (LwL)** *As a student or young professional attendee, you will **meet and interact with distinguished RAS leaders from academia and industry**. The event will feature informal roundtable discussions over lunch, which allows participants to receive career advice, gain insight into the future, or simply engage in general conversation to get to know pioneers in the field.* *Don't miss out on this chance to elevate your networking experience and make meaningful connections with figures in the world of robotics and automation.*

Social Events

Welcome Reception

Monday, September 23, 18:30 – 20:30

Kick off the conference with a casual evening of networking.

Rotterdam Ahoy

Happy Birthday ICRA

Wednesday September 25, 19:30 – 22:30

Celebrate 40 years of ICRA at the Happy Birthday ICRA Party. This event promises to be a memorable milestone for our community, featuring festivities and reflections on the journey of ICRA.

The amazing Yourband cover group will be playing an amazing playlist that YOU can *choose and vote*!

SCAN ME

https://www.yourband.party/ieeeconference

Holland America Line Cruise Terminal

Farewell Reception

Thursday, September 26, 18:30 – 20:00

This event will be the perfect conclusion to our conference, offering a final opportunity to network and celebrate with peers and colleagues.

Rotterdam Ahoy

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ICRA@40 Organizers

Prof. Wesley Roozing

ICRA@40 Exhibition and Local Chair

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Email: w.roozing@utwente.nl

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IEEE ICRA@40

	Mo., Sept 23	Tue., Sept 24	Wed., Sept 25	Thu., Sept 26
09:00–10:30	Welcome Keynotes 1	Keynotes 4	Keynotes 7	Keynotes 10
10:30–11:00	Coffee Break			
11:00–12:30	Keynotes 2	Keynotes 5	Keynotes 8 Awards*	Keynotes 11
12:30–13:15	Interactive Sessions 1	Interactive Sessions 3	Interactive Sessions 5	Interactive Sessions 7
13:15–14:15	Lunch Break			
14:15–15:00	Interactive Sessions 2	Interactive Sessions 4	Interactive Sessions 6	Interactive Sessions 8
15:00–16:30	Keynotes 3	Keynotes 6	Keynotes 9	Keynotes 12
16:30–17:00	Coffee Break			
17:00–17:30	Industry Pitches 1	Industry Pitches 2	Industry Pitches 3	Industry Pitches 4
17:30–18:30	Debate & Panel 1	Debate & Panel 2	Debate & Panel 3	Debate & Panel 4
18:30–	Welcome Reception			Farewell Reception
19:30–			Happy Birthday ICRA	
–20:00				
–20:30				
–22:30				

* Robotics Medal and Rising Star Award

Overview of Speaker Assignment

Keynotes 1

- Welcome
- Yasuo Kuniyoshi
- Atsuo Takanishi
- Sangbae Kim
- Alícia Casals
- Sven Behnke
- Kerstin Dautenhahn
- Ken Goldberg

Keynotes 4

- Katherine J. Kuchenbecker
- Allison Okamura
- Domenico Prattichizzo
- Dieter Fox
- Kostas Daniilidis
- Gregory Hager
- Jana Kosecka

Keynotes 7

- Satoshi Tadokoro
- Raja Chatila
- Antonio Bicchi
- Carme Torras
- Giorgio Metta
- Yi Guo
- Bruno Siciliano

Keynotes 10

- Dong-Soo Kwon
- Kevin Lynch
- Michael Yu Wang
- Jing Xiao
- Maria Gini
- Thomas C. Henderson
- Abderrahmane Kheddar
- Eiichi Yoshida

Keynotes 2

- Jan Peters
- Davide Scaramuzza
- Yukie Nagai
- Rüdiger Dillmann
- Dongheui Lee
- Karinne Ramirez-Amaro
- Fumitoshi Matsuno

Keynotes 5

- Bradley Nelson
- Fumihito Arai
- Nicholas Roy
- Gordon Cheng
- Giulio Sandini
- Elena De Momi
- Kyujin Cho
- Birgit Vogel-Heuser

Keynotes 8 and Awards

- Paolo Dario
- Wolfram Burgard
- Brian Scassellati
- Jens Kober
- Cynthia Breazeal

Robotics Medal and Rising Star Award

Keynotes 11

- Steven LaValle
- Zexiang Li
- Dario Floreano
- Anibal Ollero
- Soon-Jo Chung
- Antonio Franchi
- Marco Pavone
- Georgia Chalvatzaki

Keynotes 3

- Ruzena Bajcsy
- Matt Mason
- Peter Corke
- Lydia Kavraki
- Roland Siegwart
- Oussama Khatib

Keynotes 6

- Manuela Veloso
- James Kuffner
- Yoshihiko Nakamura
- Vincent Vanhoucke
- Daniela Rus
- Yiannis Aloimonos
- Oliver Brock

Keynotes 9

- Darius Burschka
- Alessandro De Luca
- Jean-Jacques Slotine
- Alin Albu-Schäffer
- Arash Ajoudani
- Ludovic Righetti
- Marc Raibert

Keynotes 12

- Barbara Mazzolai
- Marcia O'Malley
- Jessica Burgner-Kahrs
- Josie Hughes
- Kenji Suzuki
- Heike Vallery

Abstracts and Biographies

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ON ROBOTICS AND AUTOMATION

Arash Ajoudani

Autonomous and Human-Collaborative Mobile Manipulation through Hybrid Learning and Control

My talk will cover the HRI2 lab's recent advancements in contact-rich mobile manipulation tasks. Our methodology combines advanced machine learning algorithms for scene perception, human socio-physical state estimation and tracking, and high-level kino-dynamic planning with robust control to enhance the adaptability and efficiency of mobile robots in dynamic environments. The key idea is to merge model-based and data-driven techniques to enable seamless interaction between autonomous systems and human operators. Our results demonstrate significant improvements in task execution, accuracy, and safety across various application scenarios, highlighting the potential for widespread adoption in industrial, healthcare, and service robotics. This research opens new avenues for the development of intelligent robotic systems that can work harmoniously alongside humans, driving advancements in automation and collaborative technologies.

Biography

Arash Ajoudani is the director of the Human-Robot Interfaces and Interaction (HRI²) laboratory at IIT. He is a recipient of the European Research Council (ERC) proof-of-concept grant 2023 Real-Move and the ERC starting grant 2019 (Ergo-Lean), the coordinator of the Horizon-2020 project SOPHIA, the co-coordinator of the Horizon-2020 project CONCERT, and a principal investigator of the HORIZON-MSCA project RAICAM, and the national projects LABORIUS, COROMAN, and ReFinger. He is a recipient of the IEEE Robotics and Automation Society (RAS) Early Career Award 2021, and winner of the SmartCup Liguria award 2023, Amazon Research Awards 2019, of the Solution Award 2019 (MECSPE2019), of the KUKA Innovation Award 2018, of the WeRob best poster award 2018, and of the best student paper award at ROBIO 2013. His PhD thesis was a finalist for the Georges Giralt PhD award 2015 - best European PhD thesis in robotics. He was also a finalist for the best paper award on human-robot interaction at ICRA2024, the best paper award mobile manipulation at IROS 2022, the best paper award at Humanoids 2022 (oral category), the Solution Award 2020 (MECSPE2020), the best conference paper award at Humanoids 2018, the best interactive paper award at Humanoids 2016, the best oral presentation award at Automatica (SIDRA) 2014, and for the best manipulation paper award at ICRA 2012. He is the author of the book "Transferring Human Impedance Regulation Skills to Robots" in the Springer Tracts in Advanced Robotics (STAR), and several publications in journals, international conferences, and book chapters. He is currently serving as an elected IEEE RAS AdCom member (2022-2024), and as chair and representative of the IEEE-RAS Young Professionals Committee, and as a Senior Editor of the International Journal of Robotics Research (IJRR). He has been serving as a member of the scientific advisory committee and as an associate editor for several international journals and conferences such as IEEE RAL, ICRA, IROS, ICORR, etc.

Alin Albu-Schäffer

The journey of embodied intelligence and energy-aware control

In this talk I will address the evolution of robot design and control paradigms while robots became more complex, interacting with humans and moving in the wild.

The era of cooperative robots begun with the realization of light-weight robots which, using sensitive torque interfaces, approached human arm performance both in weight to load ratio and in terms of safe and compliant manipulation. Today, these concepts are widely adopted for the design and control of wheeled or legged humanoid robots and for free-flying manipulators in space or in the air. The interaction with humans and unknown environments demands for a new generation of robot control paradigms, which are energy-aware and directly control the interaction properties of the robots instead of their sole motion. To achieve maximal performance, we currently treat robot design and control increasingly interrelated. Mechatronics design embodies the desired behavior already in the intrinsic robot dynamics, for example with the appropriate joint couplings, elasticities or inertia distribution. In this sense, control and dynamics analysis influence the robot design in a very early stage. At runtime control therefore becomes minimalistic, predominantly exploiting, shaping and stabilizing the intrinsic, natural motion behavior of the robot. This promises not only robustness, but also energy efficiency and increased performance. For modelling and controlling these natural motions, we developed new tools based on differential geometry and topology. I will conclude with some recent results and a perspective on the current debate regarding model-based vs. data-based control using machine learning.

Biography

Alin Albu-Schäffer received the M.S. in electrical engineering from the Technical University of Timisoara, Romania in 1993 and the Ph.D. in automatic control from the Technical University of Munich in 2002. Since 2012 he is the head of the Institute of Robotics and Mechatronics at the German Aerospace Center (DLR), which he joined in 1995. Moreover, he is a professor at the Technical University of Munich, holding the Chair for "Sensor Based Robotic Systems and Intelligent Assistance Systems". His research interests range from robot design and control to robot intelligence and human neuroscience. He centrally contributed to the development of the DLR-light-weight robot and its technology transfer to the KUKA company, leading to a paradigm shift in industrial robot applications towards light-weight, sensitive and interactive robotics. Moreover, Alin Albu-Schäffer was strongly involved in the development of the MIRO surgical robot system and its commercialization through technology transfer to Covidien/Medtronic, the worldwide largest medical devices manufacturer. He is an author of more than 320 peer reviewed journal and conference papers and received several awards, including the IEEE King-Sun Fu Best Paper Award of the Transactions on Robotics in 2012 and 2014, the EU-Robotics Technology Transfer Award in 2011, several Best Paper Awards at the major IEEE Robotics Conferences as well as the DLR Science Award. In 2019 he received an ERC Advanced Grant for the project M-Runner, about energy efficient locomotion based on nonlinear mechanical resonance principles. He is an IEEE Fellow since 2018.

Yiannis Aloimonos

Embodied, perceptually grounded robotics

Perception and planning in robotics have been addressed as separate problems in the literature, during the past forty years. One of the consequences of this has been the development of robots that know the distance to objects in the world in meters or inches and need to be calibrated. But biological systems do not work this way. As we look at the world around us, we know where objects are because we can move our arm and touch any object (perhaps by walking towards it). In other words, our knowledge of distance is encoded in the unknown, but embodied, units of the motor system. We call this: embodied visual representation. In this way, we, and all biological systems, encode visual space in terms of the actions we can perform on that space. Psychologists assume humans have such representations without proposing a precise method for obtaining them, biologists argue how simple animals could develop them, and roboticists skip the issue entirely by pre-calibrating their robots to the meter. This results in the relatively brittle and expensive robots of today which must be recalibrated after even minor mishaps. Further, progress in the field hinges on more accurate position estimation and control in meters.

In this talk, I propose a mathematical formulation for the phenomenon of Embodied Visuomotor Representation. When developed further, it will result in inexpensive robots with lifelong adaptivity due to their constant pursuit of a self-consistent embodied visuomotor representation. I further discuss the uncalibrated clearance problem, that is determining if an uncalibrated robot in a world of unknown size, can fit through a hole before reaching the hole.

To fuse perception and planning/control, we need a common representational framework for perception and action. We believe that the most efficient representation that encapsulates perception and action is a program. A program can incorporate both motoric functions required for planning and control, and perceptual functions that are essential for sensing the environment. When called within the context of a program, these functions can be combined with expressive programming constructs such as control flow tools, making them suitable for downstream tasks such as planning. We highlight the key pillars of this representation, and discuss new research directions that arise from thinking of a robot action as a program in a practical robot planning point of view and in a more algorithmic computer science perspective. Examples will be shown from robots executing natural language instructions.

Biography

Yiannis Aloimonos is Professor of Computational Vision and Intelligence at the Dept. of Computer Science in the University of Maryland, College Park and the Director of the Computer Vision Laboratory in the Institute for Advanced Computer Studies. He is known for his work on Active Perception and the grammar of action. In Robotics he has been working on minimal perception for SWAP constrained robots, exploratory navigation, imitation learning and cognitive robots with language. He is the recipient of the Presidential Young Investigator Award and the Bodossaki Award in Artificial Intelligence. For more information see www.prg.cs.umd.edu.

Fumihito Arai

Micro and Nano Robotics – Manipulation and Automation at Small Scales in Biomedical Field

The need for manipulation and automation of micro- and nano-scale objects is increasing. Particularly in the biomedical field, genetic analysis technology is advancing rapidly, and the objects to be analyzed are now at the single-cell level.

For analytical purposes, this scale is often used for scientific exploration, such as the investigation of unknown properties of living cells and tissues, and requires precise manipulation techniques that take into account the interaction with the fluid environment under analysis. We are working on on-chip robotic systems integrating sensors and actuators on microfluidic chips. We investigated new capabilities of integrating robotic and microfluidic technologies and applied them to several scientific experimental tasks.

For automation of scientific experiments purposes, micro-objects such as cells must be individually managed from the first three-dimensional space. Such manipulation is difficult and many challenges remain. We have realized the individual management and wide-area movement of each object by integrating a microfluidic chip into the end-effector of a robotic manipulator. We developed the associated technologies required for the automation of micro and nano works.

This talk will introduce the current status of micro and nano robotics, especially manipulation and automation at small scales in the biomedical field, and discuss future prospects.

Biography

Fumihito Arai is a full Professor of the Department of Bioengineering, Department of Mechanical Engineering, at The University of Tokyo, Japan. He is mainly engaged in the research fields of bio-robotics, micro- and nano-robotics, micro- and nano-mechatoronics, MEMS, and Biomedical applications. He received a Doctor of Engineering degree from Nagoya University in 1993. Since 1998, he has been an Associate Professor at Nagoya University. Since 2005, he has been a Professor at Tohoku University. Since 2010, he has been a Professor at Nagoya University. Since 2020, he has been a Professor at the Department of Mechanical Engineering at The University of Tokyo. He was the Vice President of Technical Activities, at IEEE Robotics and Automation Society (RAS) (2014–2015) and (2016–2017). He is currently an Adcom member of RAS since 2022. He has been the Program Manager of the Moonshot R&D program on In-body Cybernetic Avatars since 2022.

Ruzena Bajcsy

Robotics at the University of Pennsylvania from Birth to Maturity: A Review of 30 Years of Research

In this talk, we have tried to present a fair overview of how and why we did research in the GRASP Laboratory since it was founded in 1979. Although I began my position at Penn in 1972, we formally established the GRASP Lab in 1979, which I ran until 2000 when I left the GRASP lab. But, of course, the GRASP lab continued.

Between 1967 and 1972, I was trained and exposed to the nascent ideas of artificial intelligence (how to represent human knowledge in the digital media), and how to possibly interact with the physical environment using mechanical-digital devices, which led to exploring robotic applications. On the positive side, I had no obstruction in my path toward pursuing my AI robotics research agenda. Yet on the negative side, there was no laboratory space that could serve our research agenda other than a small computer, the PDP 8. There were no digital cameras available to purchase, graphical displays were analog with small capacities, and manipulators were expensive without any software to control the robots. What we did have was plenty of enthusiasm. My first project at Penn was to build a digital camera using a one-dimensional silicon shift register with Aaron Snyder, a Master's student in the Electrical Engineering department. Thanks to the NSF, I received my first grant which enabled us to purchase a 6 degree of freedom robot, but we had generated all the necessary control algorithms in order to use the robot. We used Richard Paul's matrix formulations for translation and rotations. So, for the beginning, our focus was on the development of the computer vision algorithm.

Visual pattern recognition was already a well-established field with applications in medicine, quality control in manufacturing, among other industries. For us, in order to distinguish ourselves from the two-dimensional pattern recognition efforts of the AI community, we emphasized the 3D interpretation from 2D images. Our first work in this area was the PhD thesis of Mohamed Tavakoli, who analyzed Landsat images of outdoor scenes and showed the value of 3D interpretation using the knowledge of linear perspectivity. This led us to use several monocular depth cues, such as shape from shading and shape from texture. We even tried to use gradient color change with respect to depth, but our resolution was not good enough to get reliable depth information both in texture and color. Very soon, with more computer memory available, we embarked on stereo reconstruction of depth information as well from motion sequences which allowed us to compute optical flow. Note that both stereo and motion analysis was predicated by the availability of storing more data than previously.

In the 1980s, I was blessed to have several talented graduate students - Peter Allen, Eric Krotkov, and Sharon Stansfield - who built sophisticated (one of the first kind!) visual systems which had control of the head, focus, and vergence, which enabled us to reconstruct 3D data from 2D projections. Simultaneously, we acquired tactile sensors and, together with the sophisticated vision system, we were able to develop several avant garde control strategies for looking and feeling. We developed an important collaboration with Georges Giralt (Laboratory for Analysis and Architecture of Systems, Toulouse, France) and Professor Paolo Dario from Pisa, Italy, who helped us with some touch-sensitive materials. These facilities generated an ample amount of 3D data that facilitated us to explore new segmentation schemas for 3D objects, which led to Solina's PhD thesis and subsequent complex geometric analysis of common objects; i.e. superquadric parametric representation.

In the beginning of the 1990s, Sang Wook Lee focused on analysis of colored images. His deep analysis allowed us to separate highlights and detect different materials as part of their reflection. Concurrently, we focused on the signal properties of multi scale which led to Stephane Mallat's thesis of wavelet transformation and its value in multiresolution signal representation. This work was followed by that of postdoctoral researcher Visa Koivunen.

With our understanding geometry of complex 3D objects, we were ready to combine it with manipulation. This was the work of Tsikos and Campos for exploration. The control structure was implemented as a network of visual and tactile information followed by the appropriate manipulatory action. With all the tools for visual and haptic recognition, we were puzzled about how to categorize the user's interaction with the environment. Eleanor Rosch published a paper in 1978 on cognition and categorization, in which she introduced a concept of functionality as a way of characterizing the user and the tool interaction with the environment. In 1994, Luca Bogoni was, I believe, the first who showed a possible way to model this rather complex interaction. He used a knife as the tool and analyzed its material and shape to observe how it penetrates different materials in the environment's control structure. It was quite complex but necessary to use the Discrete Event System (DES) as the basis for modeling. We also used the DES as a modeling principle for moving cars in cooperative fashion and also as a cooperative system for manipulation].

In the 1990s, when we understood individual components, we turned our attention to systems composed of these individual sensors and manipulators. We studied grasping, led by Ken Goldberg and Sanjay Agrawal, and also walking, led by Pramath Sinha.

Looking back, I am proud to say that in spite of the fact that we were not at MIT, Stanford, or CMU, we still attracted outstanding students and made our contribution to the field by thinking about robotic utility and getting inspiration from psychology. I described the work of my students, but there were equally successful efforts directed by other members of the GRASP Laboratory. Notably, there was Vijay Kumar with flying drones, Richard Paul with manipulation, Max Mintz with decision-making under uncertainty, Kostas Daniilidis with novel vision algorithms, and a few others. As I was reminded by some of my former students, we also had a good number of visiting scholars from United States and international robotics labs. Some names included Tomaso Poggio from MIT, Takeo Kanade from CMU, Paolo Dario from Italy, Eleanor Rosch form Stanford, Shankar Sastry form UC Berkeley, and many others. I am proud to say that we created a dynamic and intellectually stimulating environment. My gratitude goes to all the students, postdocs and colleagues, and also the funding agencies who supported us.

Biography

Ruzena Bajcsy is Professor Emeritus at UC Berkely and the University of Pennsylvania. She received master's and PhD degrees in electrical engineering from Slovak Technical University, Bratislava, Slovak Republic, in 1957 and 1967, respectively, and a PhD in computer science from Stanford University in 1972. From 1972 to 2001 she was a professor in the Computer and Information Science Department at the University of Pennsylvania, where she established in 1978 the General Robotics, Automation, Sensing, and Perception (GRASP) Lab. As director of the GRASP lab she fostered interdisciplinary research activities and attracted faculty from electrical and mechanical engineering as well as psychology/cognitive science and of course computer science. In 2001 she accepted the positions of founding director of the Center for Information Technology Research in the Interest of Science (CITRIS) and professor of electrical engineering and computer sciences at the University of California, Berkeley. Before joining UC Berkeley, she headed the Computer and Information Science and Engineering Directorate at the National Science Foundation (1999–2001). Dr. Bajcsy is a member of the National Academy of Engineering (1997) and National Academy of Medicine (1995) as well as a fellow of the Association for Computing Machinery (ACM) and the American Association for Artificial Intelligence (AAAI). In 2001 she received the ACM/AAAI Allen Newell Award, and in November 2002 she was named one of the 50 most important women in Discover Magazine. She is the recipient of the Benjamin Franklin Medal for Computer and Cognitive Sciences (2009) and the IEEE Robotics and Automation Award (2013) for her contributions in the field of robotics and automation.

Sven Behnke

Towards Conscious Service Robots

Deep learning's success in visual perception, speech recognition, natural language processing, and multimodal models inspires hopes for advancements in autonomous robotics. However, real-world robotics face challenges like variability, high-dimensional state spaces, non-linear dependencies, and partial observability. A key issue is non-stationarity in robots and their environments, leading to performance drops with out-of-distribution data. Unlike current machine learning models, humans adapt quickly to changes and new tasks due to cognitive architectures that enable systematic generalization and meta-cognition. Human brain's System 1 handles routine tasks unconsciously, while System 2 manages complex tasks consciously, facilitating flexible problem-solving and self-monitoring. For robots to achieve human-like learning and reasoning, they need to integrate causal models, working memory, planning, and meta-cognitive processing. I propose a bottom-up approach to integrate consciousness-inspired cognitive functions into robots by enhancing System 1 processing, focusing on three research objectives: developing unconscious perception and control for routine skills, establishing conscious prediction and planning, and implementing self-monitoring for confidence assessment and risk avoidance. My team NimbRo, which developed the winning entry for the ANA Avatar XPRIZE, leverages telepresence data for learning structured perception and autonomous behavior. By incorporating human cognition insights, the next generation of service robots will handle novel situations and monitor themselves to avoid risks and mitigate errors, with applications in everyday environments. Our work with anthropomorphic mobile manipulation robots, benchmarked in the RoboCup@Home league where we recently won the German Open, showcases our progress.

Biography

Sven Behnke is full Professor for Autonomous Intelligent Systems and heads the Computer Science Institute VI – Intelligent Systems and Robotics at the University of Bonn, Germany. He directs the research area Embodied AI in the Lamarr Institute for Machine Learning and Artificial Intelligence and is founding member of the Bonn Center of Robotics. His research focuses on cognitive robotics, computer vision, and machine learning. His team NimbRo has won numerous robot competitions (RoboCup Humanoid Soccer, RoboCup@Home, MBZIRC, ANA Avatar XPRIZE). He is PI in the DFG Cluster of Excellence „PhenoRob – Robotics and Phenotyping for Sustainable Crop Production", PI in the DFG Research Unit „Anticipating Human Behaviour", Bonn coordinator in the BMBF project "RIG – Robotics Institute Germany", research coordinator in the BMBF project „WestAI Service Center for Artificial Intelligence", PI in the BMBF project „E-DRZ – Establishing the German Center for Rescue Robots (DRZ)", PI in the BMBF project „BNTrAinee: Bonn Transdisciplinary Education in Artificial Intelligence", PI in the BMBF/ANR project „Learn2Grasp: Learning Human-like Interactive Grasping based on Visual and Haptic Feedback", and PI in the BMBF project „RimA – Robots in Everyday Life". He is editor of IEEE Transactions on Robotics (T-RO) and IEEE Robotics and Automation Letters (RA-L).

Antonio Bicchi

Learning from humans how to manipulate with compliant, underactuated, and environment-driven hands

Compliant manipulation systems are often underactuated mechanisms, which have fewer motors than configuration parameters. This means that not all their postures can be reached in free space. However, virtually all natural manipulation actions are accomplished with, and thanks to, compliant hands, feet, or other end-effectors. In this talk we will discuss the role of intentional exploitation of interactions with the environment to surrogate the missing degrees-of-actuation, and will survey the evolution of mechanisms that build on this inspiration to achieve soft manipulation. We will show how their control can be inspired and generalized from human examples.

Biography

Antonio Bicchi is Senior Scientist at the Italian Institute of Technology in Genoa and the Chair of Robotics at the University of Pisa. He graduated from the University of Bologna in 1988 and was a postdoc scholar at M.I.T. Artificial Intelligence lab. He teaches Robotics and Control Systems in the Department of Information Engineering (DII) of the University of Pisa. He is the head of the SoftRobotics Lab for Human Cooperation and Rehabilitation at IIT in Genoa. Since 2013 he serves as Adjunct Professor at the School of Biological and Health Systems Engineering of Arizona State University. He is the Editor in Chief of the International Journal of Robotics Reserach (IJRR), the first scientific journal in Robotics. He was the founding Editor-in-Chief of the IEEE Robotics and Automation Letters (2015-2019). He has co-organized the first WorldHaptics Conference (2005), and is the founding President of the Italian Institute of Robotics and Intelligent Machines (I-RIM), the association of Italian Robotics researchers in academia and industry. He co-founded, as the scientist in charge, the JOiiNT Lab, an advanced tech transfer lab with leading-edge industries in the Kilometro Rosso Innovation District in Bergamo, Italy. His main research interests are in Robotics, Haptics, and Control Systems. He has published more than 500 papers on international journals, books, and refereed conferences. His research on human and robot hands has been awarded generously supported by national and EU grants, including several European Research Council Grants.

Cynthia Breazeal

Social Robots: Reflections and Predictions of Our Future Relationship with Personal Robots

In this keynote, I offer a perspective and reflections on the field of Social Robotics from its origins, its evolution and achievements, and its importance for the future. Since its inception in the late 1990s, Social Robotics introduced and advanced the socio-emotional and interpersonal dimensions of how people interact and collaborate with autonomous robots. Kismet, widely regarded as the first social robot, explored the dynamic interplay of computationally modeled socio-emotive-cognitive processes with real-time human social behavior to engage, communicate, and coordinate behavior with people. Since then, the field of Social Robotics has grown into a vibrant global community that has continued to advance three key areas and their interplay 1) the computational science of endowing autonomous robots with greater social and emotional skills and intelligence, 2) the interaction design of social robots for a wide range of tasks and contexts where human-robot collaboration and rapport are important and 3) the psychological science of understanding how people experience and are influenced by their interaction with social robots in increasingly sophisticated ways over longer periods of time. Twenty-five years since its origins, we are witnessing social robots begin to enter consumer and industrial markets in manufacturing, healthcare, education, aging, entertainment, mobility, consumer products, and more. This promise also raises important issues, challenges, and opportunities for how to design social robots and other personified AI technologies in an ethical and responsible way to promote human flourishing and social good.

Biography

Cynthia Breazeal is a Professor at the MIT Media Lab where she directs the Personal Robots Group. She also director of the MIT initiative on Responsible AI for Social Empowerment and Education (RAISE) and is MIT Dean of Digital Learning with MIT Open Learning. She is recognized as a pioneer of social robotics and human-robot interaction, is a fellow of the AAAI, and has commercialized personal robots for the home as Chief Scientist and Chief Experience Officer for Jibo Inc. Her work balances technical innovation in AI, UX design, and understanding the psychology of engagement to design personified AI technologies that promote human flourishing and personal growth in areas such as education, emotional wellness, aging, and more. She is an international award-winning innovator, designer, and entrepreneur. She did her graduate work at the MIT AI Lab and received her doctorate in 2000 in Electrical Engineering and Computer Science from MIT.

Oliver Brock

Intelligence: Artificial, Biological, Embodied

Everybody is talking about intelligence these days. But the concept is neither well-defined nor well-understood. Of course, we must acknowledge the tremendous advances achieved by the current wave of artificial intelligence, based on deep learning, large language models, and foundation models. But is this form of AI really an artificial version of the biological example? I will argue that despite all technological advances, we have not gotten much closer to an understanding of intelligence. As a result, a fundamental performance gap remains between biological and artificial systems when we consider robustness, generality, and adaptability. Closing this gap is one of the goals of a research program called “Science of Intelligence.” I will report on progress achieved within this program towards conceptualizing intelligence and leveraging the resulting insights for building robotic systems.

Biography

Oliver Brock is the Alexander-von-Humboldt Professor of Robotics in the School of Electrical Engineering and Computer Science at the Technische Universität Berlin, a German "University of Excellence". He received his Ph.D. from Stanford University in 2000 and held postdoctoral positions at Rice University and Stanford University. He was an Assistant and Associate Professor in the Department of Computer Science at the University of Massachusetts Amherst before moving back to Berlin in 2009. The research of Brock's lab, the Robotics and Biology Laboratory, focuses on embodied intelligence, mobile manipulation, interactive perception, grasping, manipulation, soft material robotics, interactive machine learning, motion generation, and the application of algorithms and concepts from robotics to computational problems in structural molecular biology. Oliver Brock directs the Research Center of Excellence "Science of Intelligence". He is an IEEE Fellow and was president of the Robotics: Science and Systems Foundation from 2012 until 2019.

Wolfram Burgard

Probabilistic and Deep Learning Techniques for Robot Navigation and Automated Driving

For autonomous robots and automated driving, the capability to robustly perceive environments and execute their actions is the ultimate goal. The key challenge is that no sensors and actuators are perfect, which means that robots and cars need the ability to properly deal with the resulting uncertainty. In this presentation, I will introduce the probabilistic approach to robotics, which provides a rigorous statistical methodology to deal with state estimation problems. I will furthermore discuss how this approach can be combined using state-of-the-art technology from machine learning and foundation models to deal with complex and changing real-world environments.

Biography

Wolfram Burgard is a distinguished Professor of Robotics and Artificial Intelligence at the University of Technology Nuremberg where he also serves as Founding Chair of the Engineering Department. Previously, he held the position of Professor of Computer Science at the University of Freiburg from 1999 to 2021, where he established the renowned research lab for Autonomous Intelligent Systems. His expertise lies in artificial intelligence and mobile robots, focusing on the development of robust and adaptive techniques for state estimation and control. Wolfram Burgard's achievements include deploying the first interactive mobile tour-guide robot, Rhino, at the Deutsches Museum Bonn in 1997. He and his team also developed a groundbreaking approach that allowed a car to autonomously navigate through a complex parking garage and park itself in 2008. In 2012, he and his team developed the robot Obelix that autonomously navigated like a pedestrian from the campus of the Faculty of Engineering to the city center of Freiburg. Wolfram Burgard has published over 350 papers and articles in robotic and artificial intelligence conferences and journals. Additionally, he co-authored the two books “Principles of Robot Motion - Theory, Algorithms, and Implementations” and “Probabilistic Robotics”. In 2009, he was honored with the Gottfried Wilhelm Leibniz Prize, the most prestigious research award in Germany. He is a member of the Heidelberg Academy of Sciences and the German Academy of Sciences Leopoldina.

Jessica Burgner-Kahrs

Open Continuum Robotics

Continuum robots, with their distinct morphology characterized by long, slender, and flexible structures, offer unparalleled capabilities in navigating confined spaces and manipulating objects in complex environments. Their ability to bend, extend, contract, and twist enables traversal along curvilinear paths, presenting capabilities beyond traditional robot embodiments. Applications of continuum robots span diverse fields, including minimally invasive surgery in medicine and the inspection, maintenance, and repair of complex machinery in industrial settings, such as turbojet engines and chemical piping systems. However, these unique features pose substantial research challenges. In this talk, we will explore methodologies for designing continuum robot bodies and actuation mechanisms, as well as for developing efficient yet precise models. We will also discuss strategies for state estimation with limited sensor data and the strategic utilization of environmental interactions to improve maneuverability. Additionally, the talk will highlight the crucial role of knowledge mobilization within our field and showcase the Open Continuum Robotics Project. Attendees will gain insights into the latest advancements pushing the boundaries of what continuum robots can achieve in real-world applications.

Biography

Jessica Burgner-Kahrs is Professor with the Departments of Mathematical & Computational Sciences, Computer Science, and Mechanical & Industrial Engineering, the founding Director of the Continuum Robotics Laboratory, and Associate Director of the Robotics Institute at the University of Toronto, Canada. She received her Diploma and Ph.D. in computer science from Karlsruhe Institute of Technology (KIT), Germany in 2006 and 2010 respectively. Before joining the University of Toronto, she was Associate Professor with Leibniz University Hannover, Germany and a postdoctoral fellow with Vanderbilt University, USA.

Her research was recognized with the Heinz Maier-Leibnitz Prize, the Engineering Science Prize, the Lower Saxony Science Award in the category Young Researcher, and she was entitled Young Researcher of the Year 2015 in Germany. She was elected as one of the Top 40 under 40 in the category Science and Society in 2015, 2016, and 2017 by the business magazine Capital and elected one of 100 Young Global Leaders from the World Economic Forum in 2019. Jessica is a Senior member of the IEEE, a Distinguished Lecturer of IEEE RAS, and serves as a senior editor for IEEE RA-L.

Darius Burschka

Understanding of Motion in Static and Dynamic Environments from Monocular Video Streams – Evolution of Optical Flow Research in Robotics

Image motion of physical 3D points in the scene provides a robust way to understand camera motion and to analyze activities in robotic applications. This change in the position of projected scene points connected with vectors represents the optical flow. It represents directly the motion relations between the camera and a static or dynamic scene object. Usage of optical flow directly for control has a long history in robotic applications to avoid calibration errors. The initial method to guide a manipulator vision-based to the goal was to evaluate the difference between an expected and the actual position of tracked physical points in visual servoing and Jacobian-based motion generation in visual-map approaches. Flow analysis in Epipolar Geometry is used for structure from motion approaches to understand camera motion in static environments and for validation of point correspondences in image sequences. The transition to dynamic scenes brought new segmentation methods of independent motion components and identification of collision relations directly in the image without any metric 3D information. It is currently used in autonomous driving, motion planning in crowded scenes and aeronautic sense-and-avoid applications for flying systems. The work motivates a new way of modeling of dynamic environments using time-to-collision relations for planning under dynamic conditions.

Biography

Darius Burschka received his PhD degree in Electrical and Computer Engineering in 1998 from the Technische Universitätt München in the field of vision-based navigation and map generation. Later, he was a Postdoctoral Associate at Yale University, Connecticut and Assistant Research Professor in Computer Science at Johns Hopkins University. Currently, he is a Professor in Computer Engineering at the Technische Universität München (CIT), where he heads the Machine Vision and Perception group. He acted as Editor in Computer Vision for IROS and ICRA conferences and on many vision and robotics program committees. He is a Science Board Member of the Munich Institute for Robotics and Machine Intelligence. His areas of research are sensor systems for mobile and medical robots and human computer interfaces. The focus of his research is on vision-based navigation, three-dimensional reconstruction from sensor data and action analysis. He is a Senior Member of IEEE.

Alícia Casals

Redundancy in multi-arm platforms — A trade-off for its usability in surgical robotics

Surgical robotic systems require multiarm operation sharing a common workspace and facing the difficulty that the arms work very close to each other creating many collision situations, which forces the use of redundant architectures. Laparoscopic surgery implies in addition operating the instruments through a trocar (Remote Center of Motion, RCM) that imposes a specific kinematic constraint. This entails having to face strong challenges to make possible collision free movements while maintaining its effectivity along a surgical procedure. The solutions adopted by the existing multirobot platforms are very diverse and therefore offer different usability performance. A lot of research has been done into the development of techniques on how to deal with redundancy, focusing on the operativity space, null space and multiobjective optimization among others. In this talk I will discuss the solutions adopted by the different surgical robot suppliers for their various robot architectures, considering the incidence of the kinematic solution on its usability in the operating room.

Biography

Alícia Casals is full Professor of Robotics at the Technical University of Catalonia (UPC). Her background is in Electrical and Electronics Engineering and PhD in Computer Vision. She is head of the research group on Robotics and Computer Vision from the Center of Research in Biomedical Engineering (CREB) at UPC. Her research field is in robotic systems and control strategies for rehabilitation, assistance and surgical applications. This research implies integrating knowledge in various disciplines, from sensing, intelligent data interpretation, control as well as in the design and development of robotic systems, for specific application-oriented research. The result of the research has led to numerous publications in Conferences and Journals, in a collection of patents and being cofounder and member of the board of a medical robotics company, Rob Surgical. She belongs to different national and international societies with a key role in them and in the organization of international events and involvement journals. At present she is President of the Science and Technology Section of the Institut d'Estudis Catalans (the Academy of Catalonia).

Georgia Chalvatzaki

Mobile Manipulation Skills & Why We Need Them

In the quest to create robots that can seamlessly integrate into our dynamic world, mobile manipulation (MoMa) is the key to unlocking true autonomy. This talk delves into the advancements in learning MoMA that enable robots to perform complex tasks efficiently, even in unpredictable environments. We explore the challenges of sensorimotor coordination, real-time perception, and the development of skills that allow robots to not just act but to understand and adapt to their surroundings. Join me as we delve into the methods and innovations shaping the future of robotics, where machines evolve from mere tools to adaptive partners capable of navigating our dynamic world.

Biography

Georgia Chalvatzaki is a Full Professor (W3) for Interactive Robot Perception and Learning at the Computer Science Department of the TU Darmstadt. She has been awarded an AI Emmy Noether DFG research grant in 2021 and received several awards (IROS 2022 Best Paper Award in Mobile Manipulation, Best Paper Award at the RSS2024 Workshop on Priors4Robots, Best Paper Award at the ICRA 2023 Workshop on Geometric Representations, Outstanding Associate Editor RA-L 2023, Top Reviewer NeurIPS2023, Junior Researcher for 2021– top 10, Daimler and Benz Foundation Scholarship 2022, 2021 AI Newcomer German Informatics Society, Robotics Science and Systems Pioneer 2020, 4 Best Paper and Student Paper Award Finalist), 40 Keynotes in distinguished international workshops and conferences, and over 60 publications.

Raja Chatila

The “intelligent connection of perception to action”

Robotics has been defined by Michael Brady in 1985 as the “intelligent connection of perception to action”. Forty years later, despite major paradigm variations, the quest for robots (physical machines situated and acting in the real world) that would genuinely correspond to this definition is still ongoing. Today’s robots – as sophisticated and agile they may be – still lack this intelligent connection and remain confined within little cognition and decision-making capacities even when they accomplish impressive dexterous tasks. On the other hand, the most advanced current Artificial intelligence systems (Large Language Models, Large Multimodal Models) have no connection at all either to perception or to action in the real world, and lack semantic grounding. What is missing? In both cases, the artificial agent itself is actually a mechanism inserted in the world but not belonging to it. This talk will discuss how a robot-centric perspective for such an integration can be developed for the robot to understand its environment while learning to build its own representations and actions.

Biography

Raja Chatila is Professor Emeritus at Sorbonne University in Paris, France. He contributes in several fields of Artificial Intelligence and autonomous and interactive Robotics including perception, motion planning and control, decision-making and task planning, human-robot interaction, learning, cognitive architectures, as well as AI and Robotics technology ethics. He is the author of over 180 publications on these topics.

He was director of the Institute of Intelligent Systems and Robotics (2014-2018) and of the SMART Laboratory of Excellence on Human-Machine Interactions (2012-2020) at Sorbonne University. He was also director of the Laboratory of Systems Analysis and Architecture in Toulouse (2007-2010). He is past president of the IEEE Robotics and Automation Society (2014-2015 and chair of the IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems, past co-chair of the Responsible AI working group of the Global Partnership on AI and member of the French National Pilot Committee on Digital Ethics. He is an IEEE Fellow and recipient of the IEEE Robotics and Automation Society Pioneer Award, the Distinguished Services Award and the George Saridis Leadership Award.

Gordon Cheng

Tactile Intelligence for Robots

Throughout our lives, we rely on our “sense of touch”; this versatile sense provides us with awareness of the world that dominates our daily lives. With the substantial advances in the whole-body sense of touch in robotics, new capabilities, “tactile intelligence,” that go beyond the usual perceptual ability of robotic systems are expanding – enabling robots to sense and physically act in the world closer to the way humans do. Significant challenges must be overcome to bring forward “tactile intelligence” for robots, which can substantially bring robotics to a new height. In this talk, I present a neuroscience-based approach that enables the realization of a complete artificial multimodal sensitive skin system designed to be deployed on “any” robots to enable them with “tactile intelligence.” I will specifically show several examples, including whole-body humanoid-robot interaction, human-robot interaction, enhanced humanoid locomotion, robot navigation among movable objects, locomotion control of bipedal exoskeleton, and robot-robot collaboration.

Biography

Gordon Cheng has made pioneering contributions in Humanoid Robotics, Neuroengineering, and Artificial Intelligence for more than 20 years. Since 2010, he holds the Chair Professor for Cognitive Systems, and the Director of the Institute for Cognitive Systems at the Technical University of Munich, Germany. Prof. Cheng is the Program Director of the Elite Master of Science in Neuroengineering of the Elite Network of Bavaria, a highly selective and unique study program in Germany. He is also the coordinator of the Center of Competence Neuro-Engineering. Gordon Cheng is the co-inventor of 20 patents and has co-authored over 450 technical publications, proceedings, editorials, books, and book chapters. The IEEE acknowledged this interdisciplinarity when he was named IEEE Fellow in 2017 for his “contributions in humanoid robotic systems and neurorobotics.” His research interests include NeuroRobotics, Humanoid Robotics, Imitation Learning, Cognitive Systems, Artificial Intelligence and NeuroEngineering.

Kyujin Cho

Soft Wearable Robots: Creating Technology to Enhance Human Capabilities

The innovative field of soft wearable robots, designed to seamlessly integrate into daily life with unparalleled comfort and flexibility, utilizes textile materials or soft materials to create wearable robots that are lightweight and flexible. Compared to exoskeletons that use rigid frames to transmit the actuation force to the body part, soft wearable robots transmit the forces using tendons, straps, or a composite of rigid and soft material. Naturally, they tend to have less constraints in terms of degrees of freedom, and has the potential to become a part of everyday life. These robots will provide significant benefits in healthcare, aiding rehabilitation and enhancing the quality of life for individuals with disabilities and the elderly. We will discuss the design principles, functionality, and applications of soft wearable robots, and address current challenges and future prospects.

Biography

Kyujin Cho is a Professor and the Director of Soft Robotics Research Center and Biorobotics Lab at Seoul National University. He received his Ph.D. in mechanical engineering from MIT and his B.S and M.S. from Seoul National University. He was a postdoctoral fellow at Harvard Microrobotics Laboratory before joining SNU in 2008. He has been exploring novel soft bio-inspired robot designs, including a water jumping robot, various shape-changing robots and soft wearable robots for the disabled. He has received the 2014 IEEE RAS Early Academic Career Award for his fundamental contributions to soft robotics and biologically inspired robot design. He has published a Science paper on water jumping robot and several papers in Science Robotics with novel robot designs. He has served RAS as Associate VP of Publication Activities Board, a general chair of RoboSoft 2019, management committee chair of TMECH. Currently, he serves as VP of the RAS Technical Activities Board and General Chair of ICRA2027.

Soon-Jo Chung

Learning and Decision Making for Fast Robots under Failures

Conventional ML methods require huge amounts of data to train, making real-time re-training of an entire deep neural network nearly unfeasible for fast-moving small robots. Our Neural-Fly and subsequent work (NF-Fault Tolerance and MAGIC ground vehicle control using Visual Foundational Model) overcame those limitations by identifying and rapidly adapting the low-dimensional parameters that must be updated in real time. The key innovation is to systematically guarantee stability and safety in a hierarchically separated architecture using contraction stability theory. Exponential convergence to controllable bounds by contraction provides superior robustness and safety guarantees for robot learning and tracking control compared to popular methods of reinforcement learning and barrier function methods. I will also discuss our recent results of rapid Monte Carlo Tree Search algorithms for fault estimation, decision making, and motion planning for robot dynamics (S-FEAST and SETS methods).

Biography

Soon-Jo Chung is Bren Chair Professor of Control and Dynamical Systems in the California Institute of Technology. He is also a Senior Research Scientist of the NASA Jet Propulsion Laboratory. Prof. Chung received his Sc.D. degree in Estimation and Control from MIT. Prior to joining Caltech in 2016, Prof. Chung was an associate professor at the University of Illinois at Urbana-Champaign. His research focuses on autonomous vehicles, aerospace robotics, and space autonomous systems, and in particular, on the theory and application of control, estimation, learning-based control and planning, and navigation of autonomous vehicles. Prof. Chung was an Associate Editor of the IEEE Transactions on Automatic Control and the IEEE Transactions on Robotics. He was the Guest Editor on Aerial Swarm Robotics published in the IEEE Transactions on Robotics.

Peter Corke

The Robotics Toolbox – 30 years old and still going strong

The Robotics Toolbox for MATLAB was created over 30 years ago and has been used by generations of students for learning and research, and the ideas have percolated into many other software tools. In this talk, I will discuss the history and evolution of the toolbox and its use in supporting the Robotics, Vision & Control book. I will also talk about how it has influenced MATLAB itself, the design principles for the recent reimplementation in Python, and how these have supported the third editions of the book. I will conclude with speculation about the future of the toolbox and textbooks in general.

Biography

Peter Corke is a robotics practitioner, researcher and educator. He is currently Chief Roboticist of LYRO Robotics and technical advisor to emesent; an adjunct science fellow with CSIRO; and chair of the Robotics Council of the Robotics Australia Network. He is a distinguished professor emeritus at Queensland University of Technology; founder and former director of the QUT Centre for Robotics (2020-23); founding director of the ARC Centre of Excellence for Robotic Vision (2014-20), and founding director of CSIRO's Autonomous Systems Lab (2004-09). His research has been concerned with enabling robots to see, and in particular robotic hand-eye coordination. His application interests include robots for mining, agriculture, construction, and environmental monitoring. He created widely used open source software for teaching and research in MATLAB and Python; wrote the best-selling textbook "Robotics, Vision, and Control", now in its third edition; created several MOOCs and the Robot Academy; and has won national and international recognition for teaching, including 2017 Australian University Teacher of the Year. He is a fellow of the IEEE, the Australian Academy of Technology and Engineering, the Australian Academy of Science; former editor-in-chief of the IEEE Robotics & Automation magazine; founding editor of the Journal of Field Robotics; founding multi-media editor and former executive editorial board member of the International Journal of Robotics Research; member of the editorial advisory board of the Springer Tracts on Advanced Robotics series; recipient of the Qantas/Rolls-Royce and Australian Engineering Excellence awards; and has held visiting positions at Oxford, University of Illinois, Carnegie-Mellon University, and University of Pennsylvania. He received his undergraduate and masters degrees in electrical engineering and PhD from the University of Melbourne.

Kostas Daniilidis

Efficient Robot Perception Through Symmetry, Active Sensing, and Event-Vision

Scaling up data and computation is regarded today as the key to achieving unprecedented performance in many visual tasks. The success of foundation models has been called the bitter lesson. Biological perception is characterized though by principles of efficiency implemented through symmetry, efficient, and active sensing. In this talk we will present recent results and a vision for small scale perception for robots by using networks with built-in equivariance and by actively sampling the scene. Moreover, robots can greatly benefit from low-power low-bandwidth sensors that enable fast reactive behavior such as cameras implementing the event-based paradigm.

Biography

Kostas Daniilidis is the Ruth Yalom Stone Professor of Computer and Information Science at the University of Pennsylvania where he has been faculty since 1998. He is an IEEE Fellow. He was the director of the GRASP laboratory from 2008 to 2013, Associate Dean for Graduate Education from 2012-2016, and Faculty Director of Online Learning from 2013- 2017. He obtained his undergraduate degree in Electrical Engineering from the National Technical University of Athens, 1986, and his PhD in Computer Science from the University of Karlsruhe, 1992, under the supervision of Hans-Hellmut Nagel. He received the Best Conference Paper Award at ICRA 2017. He co-chaired ECCV 2010 and 3DPVT 2006. His most cited works have been on event-based vision, equivariant learning, 3D human pose, and hand-eye calibration. His hand-eye calibration using dual quaternions is the default option in MoveIt/ROS.

Paolo Dario

Biorobotics and Bionics: from Dream to Reality

Biography

Paolo Dario is a Professor of Biomedical Robotics and Director of The BioRobotics Institute of the Scuola Superiore Sant'Anna (SSSA), Pisa, Italy. He has been Visiting Professor at Brown University, Providence, RI, USA; at the École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland; at the École Normale Superieure de Cachan, France; at the College de France, Paris, France; at the Polytechnic University of Catalunya, Barcelona, Spain; at Waseda University, Tokyo, Japan; at Zhejiang University, Hangzhou and at Tianjin University, China.

His main research interests are in the fields of medical robotics, bio-robotics, bio-mechatronics and micro/nano engineering and robotics. He is the coordinator of many national and European projects, the editor of two books on the subject of robotics, and the author of more than 500 scientific papers (300+ on ISI journals). Prof. Dario has been and is Editor-in-Chief, Associate Editor and member of the Editorial Board of many international journals. He has been program chair and plenary invited speaker in many international conferences (including IEEE ICRA, IROS and EMBC). He has been also the General Chair of the 1st IEEE RAS/EMBS Conference on Biomedical Robotics and Biomechatronics (BioRob 2006), and of the IEEE International Conference on Robotics and Automation (ICRA 2007).

He is also a member of the Board of the International Foundation of Robotics Research (IFRR) and a Fellow of the School of Engineering, University of Tokyo. He has served and serves in many Boards and Committees, including the IST Advisory Group (ISTAG) of the European Commission, the Horizon 2020 Advisory Group on Societal Challenge 1 'Health, demographic change and wellbeing' of the European Commission, the Technology Council of ST Microelectronics, the International Scientific Committee of the Institute for Bioengineering of Catalonia (IBEC), the

Global Agenda Council on Robotics and Smart Devices of the World Economic Forum, the Scientific Advisory Board of the Advanced Robotics Centre of the National University of Singapore, and the Board of Directors of the euRobotics AISBL, the entity promoting the creation of a Public Private Partnership in Robotics in Europe. He has promoted the creation of more than 20 start-up companies active in the market of biomedical devices and services, and he is/has been a partner of 5 of these start-up companies.

Professor Paolo Dario is IEEE Fellow, Fellow of the European Society on Medical and Biological Engineering, and a recipient of many honors and awards, such as the Joseph Engelberger Award. He is the recipient of the prestigious 2024 IEEE Robotics and Automation Award “for establishing and advancing bionics and biorobotics as key research areas worldwide, integrating robotics and medicine.”

Kerstin Dautenhahn

Complexities of a Co-Design Approach to Developing Social Robots for Real World Applications

A number of applications of intelligent robots involve close and/or repeated communication and interaction with its users. Those applications include assistive robotics, e.g. developing social robots for therapy and education of children with disabilities, developing care robots for older adults, or robots as mental health coaches. My team at University of Waterloo follows a dedicated co-design approach, where users (e.g., teachers, instructors, therapists etc.) are not only informants and participants in studies, but directly inform the research goals, directions, and study design. Such an approach is fundamentally different from research that sets out with particular goals and research directions, and only involves stakeholders during formative or summative evaluations, but not as research collaborators who have a strong and equal say in the development of the robotic systems. However, such an approach comes with its own challenges and complexities. My talk will outline some of those challenges that researchers who take this direction need to be aware of. My take home message will be: Co-design is not easy, it requires researchers to step back from the driver's seat in the research, but it results in truly transdisciplinary research, where robotic systems are developed collaboratively, and which often leads to surprising and innovative insights and solutions.

Biography

Kerstin Dautenhahn is full Professor and Canada 150 Research Chair in Intelligent Robotics in the Department of Electrical and Computer Engineering at the University of Waterloo, Canada. She is director and a founder of the Social and Intelligent Robotics Research Lab (SIRRL) which was established in 2018. Prior to moving to Canada she coordinated the Adaptive Systems Research Group at the University of Hertfordshire where she pioneered research on robot-assisted therapy for children on the autism spectrum, leading the design of the robot Kaspar, as well as founding the UH Smart Home "Robot House" – an ecologically valid testbed for prototyping home assistance robots. She has been involved in numerous EU projects, e.g. Cogniron, Robotcub, Accompany, LIREC, Babyrobot. Her research interests are in Human-Robot Interaction and Social Robotics, including basic research, but with a focus on assistive applications. Since moving to Canada she has established several new research directions, e.g. developing social robots as tools for the stuttering clinic, to supported instruction of children with learning disabilities, to support Speech and Language Pathologist (SLPs), or developing robots as coaches for publication speaking and mental health support for students. She has several senior editorial roles for international journals, and is frequently invited to give keynote talks. She closely collaborates with various stakeholders in assistive robotics applications, through co-design.

Alessandro De Luca

Safe Control of Physical Human-Robot Interaction

The handling of tasks that involve physical Human-Robot Interaction (pHRI) requires basic capabilities that the robot control architecture should guarantee in a safe and effective way: share the workspace during parallel human/robot operations; detect and isolate intentional contacts and unexpected collisions, possibly distinguishing between the two; promptly react to such events according to the context; and establish a physical collaboration in which a controlled exchange of forces takes place during coordinated motion. I will review some of our model-based solutions to these problems, implemented during the last 15 years or so on lightweight and compliant manipulators as well as on industrial robots, using proprio- and exteroceptive sensory data and designing suitable task-oriented control laws. A discussion on current challenges and on integration with data-driven methods for safe pHRI concludes the talk.

Biography

Alessandro De Luca is Professor of Robotics and Automation at the Sapienza University of Rome, Italy. His research interests cover modeling, motion planning, and control of robotic systems (flexible manipulators, kinematically redundant arms, underactuated robots, wheeled mobile robots), as well as physical human-robot interaction. He was the scientific coordinator of the FP7 project SAPHARI – Safe and Autonomous Physical Human-Aware Robot Interaction (2011-15). He has been the first Editor-in-Chief of the IEEE Transactions on Robotics (2004-08), RAS Vice-President for Publication Activities in 2012-13, General Chair of ICRA 2007, Program Chair of ICRA 2016, and General Chair of the first Italian conference on Robotics and Intelligent Machines (I-RIM) in 2019. He received three conference awards (Best paper at ICRA 1998 and BioRob 2012, Best application paper at IROS 2008) and a journal excellence award (Mechanism and Machine Theory, in 2017), the Helmholtz Humboldt Research Award in 2005, the IEEE-RAS Distinguished Service Award in 2009, and the IEEE George Saridis Leadership Award in Robotics and Automation in 2019. He is an IEEE Life Fellow.

Elena De Momi

Autonomy in robotic surgery – from the bench to the bedside

The final goal of research towards automation (either in the automotive or in the surgical robotic field) is directed towards the increase of safety and, ultimately, to increase the surgical outcome. Robotics systems embedding artificial intelligence have already been cleared and entered the market to allow for better surgical interventions. In this talk, I will discuss the competitive advance of artificial intelligence in surgical autonomy for empowering surgeons with super-human capabilities. I will specifically focus on clinical testing and steps that would lead to the clinical translation of such methods in the clinical routine to perform complex interventions, mentioning potential barriers. I will conclude with a discussion of the major challenges and the transformative impact surgical robots hold for the future of the healthcare systems.

Biography

Elena De Momi is Associated Professor of Bioengineering in the Department of Electronics, Information and Bioengineering at Politecnico di Milano, Italy. Her research focuses on computer vision for minimally invasive surgery, endoluminal robots and human-robot interaction.

She is co-founder of the Neuroengineering and Medical Robotics Laboratory, in 2008, being responsible of the Medical Robotics section. IEEE Senior Member, she is currently Senior Editor of the Int. Journal of Robotics Research, Editor of the IEEE Robotics and Automation Magazine and Associate Editor of IEEE Transaction on Robotics and Robotics and Automation Letters. She has been Publication Chair and Co-Chair for IEEE ICRA 2019, 2023 and 2024 and is Program Chair of IROS 2025. She is responsible for the lab course in Medical Robotics, of the courses on Clinical Technology Assessment and Smart Hospital of the MSc degree in Biomedical Engineering at Politecnico di Milano and she serves in the board committee of the PhD course in Bioengineering and of the National PhD in Robotics and Intelligent Machines.

Rüdiger Dillmann

Learning of Robot Behaviour and Skills from Human Task Demonstration and Activity Observation

Today's robots require effective programming methods that support human users to easily generate code for motion, controls, perceptual skills or complex task strategies as well as to transfer human experience to machines. To achieve this goal, effective methods are required to transfer knowledge derived from sensor streams, real and virtual experiments into executable robot code. Skills must be learned from human demonstrations and from other knowledge sources, such as web-based knowledge bases, while taking into account hard- and software constraints. Various Programming by Demonstration (PbD) methodologies for interactive robot programming have been proposed in the last decades are widely used in practice. These PbD-systems combine symbolic and subsymbolic learning approaches mimicking natural task programming exploiting human demonstrations, advice and recently large language models (LLM). However, these systems still lack the ability to supervise and influence the program generation process after the initial demonstration. In this talk, I will discuss how we can exploit advanced machine learning methods to transfer human skills to robots while supervising the underlying learning process by combining model-based and data-driven methods for acquiring task knowledge from multi-modal human observation. The talk will present frameworks developed at KIT and FZI to learn skills and task knowledge, to adapt behavior and to mitigate situative risks, and discuss their potential to explore new task domains and increase robot's performance and autonomy.

Biography

Rüdiger Dillmann is Professor Emeritus at the Karlsruhe Institute of Technology (KIT), Germany. He received his PhD from the University of Karlsruhe in 1980. Since 1987 he has been Professor at the Computer Science Department and Director of the Humanoids and Intelligence Systems Lab at KIT. He has served as Research Director at the Research Center for Information Science (FZI) in Karlsruhe since 2002. In 2009 he founded the Institute of Anthropomatics and Robotics (IAR) at KIT and served as its spokesperson for several years. His research interests lie in the areas of humanoid robotics with special emphasis on intelligent, autonomous and interactive robot behaviour based on machine learning methods and robot Programming by Demonstration (PbD). Other research interests include machine vision for autonomous mobile robot systems, human-robot interaction, computer-supported intervention in surgery and related simulation techniques. At FZI, he coordinates research on heterogeneous autonomous robot teams for applications in non-human-friendly environments like space, critical infrastructures and nuclear decommissioning. He is the founding Editor-in-Chief of the journal "Robotics and Autonomous Systems", Elsevier, and Editor-in-Chief of the Springer series COSMOS. He is IEEE Fellow and life member.

Dario Floreano

From flying animals to drones and back

Drones have taken the world by storm. In only 15 years, small autonomous flyers have had major impact in inspection, security, rescue, logistics, and entertainment. However, today's commercial drones cannot yet compete with flying animals in terms of mechanical resilience, adaptability, and cooperation. For example, multi-copters are very agile, but spend most of their energy to fight gravity; in contrast, winged drones offer almost twice as much endurance than multi-copters for the same mass but require more space and time to change direction. I will describe recent research addressing these challenges that take inspiration from insects and birds, describe how such drones can be used to explain poorly understood biological mechanisms, and show examples of translation into commercial products. Finally, I will point out remaining challenges in design, modeling, and control of future drone systems.

Biography

Dario Floreano is full professor and director of the Laboratory of Intelligent Systems at Ecole Polytechnique Fédérale de Lausanne (EPFL). He has been the founding director of the Swiss National Center of Competence in Robotics from 2010 to 2022. Prof. Floreano made pioneering contributions to the fields of evolutionary robotics, aerial robotics, and soft robotics. He is interested in deriving mechanical design and autonomous control principles from nature and in using robots as models of biological systems. He held visiting research positions at Sony Computer Science Laboratory, at Caltech/JPL, and at Harvard University. He co-authored more than 400 publications and 5 books by MIT Press and Springer Verlag, spun off 3 drone companies (senseFly, Flyability, Elythor), and is in the editorial board of several journals, including Science Robotics. He received numerous awards, and is fellow of the IEEE, ELLIS, and ECLT societies.

Dieter Fox

Where is RobotGPT?

The last years have seen astonishing progress in the capabilities of generative AI techniques, particularly in the areas of language and visual understanding and generation. Key to the success of these models are the use of image and text data sets of unprecedented scale along with models that are able to digest such large datasets. We are now seeing the first examples of leveraging such models to equip robots with open-world visual understanding and reasoning capabilities. Unfortunately, however, we have not achieved the RobotGPT moment; these models still struggle with reasoning about geometry and physical interactions in the real world, resulting in brittle performance on seemingly simple tasks such as manipulating objects in the open world. A crucial reason for this problem is the lack of data suitable to train powerful, general models for robot decision making and control. In this talk, I will discuss approaches to generating large datasets for training robot manipulation capabilities, with a focus on the role simulation can play in this context. I will show some of our prior work, where we demonstrated robust sim-to-real transfer of manipulation skills trained in simulation, and then present a path toward generating large scale demonstration sets that could help train robust, open-world robot manipulation models.

Biography

Dieter Fox is Senior Director of Robotics Research at NVIDIA and Professor in the Allen School of Computer Science & Engineering at the University of Washington, where he heads the UW Robotics and State Estimation Lab. Dieter's research is in robotics and artificial intelligence, with a focus on learning and perception applied to problems such as robot manipulation, mapping, and object detection and tracking. He has published more than 200 technical papers and is the co-author of the textbook “Probabilistic Robotics”. He is a Fellow of the IEEE, AAAI, and ACM, and recipient of the 2020 IEEE Pioneer in Robotics and Automation Award and the 2023 IJCAI John McCarthy Award. He was an editor of the IEEE Transactions on Robotics, program co-chair of the 2008 AAAI Conference on Artificial Intelligence, and program chair of the 2013 Robotics: Science and Systems conference.

Antonio Franchi

Aerial Robotics: Lessons Learned and Future Directions in Modelling and Control

Current research in aerial robotics (drones and UAVs) sees an abundance of data-driven approaches mainly focused on perception and other AI-related problems. Research on design, modeling, and formal control - the backbone of the past decades - seem to suffer a period of decline in terms of popularity. Perhaps there are no more relevant open control problems for UAVs; or maybe still unsolved problems are now perceived as solved because of some sort of 'mass hallucination'; or perhaps the attention is now distracted by other problems which have been neglected in the past because too hard to solve and now seem/are finally within reach thanks to the new AI wave; or maybe the problems still open in control are so difficult that everybody prefers to ignore them, like the 'Fox and the Grapes'. Or perhaps there is no decline in popularity at all and this research field is in very good shape but just not advertised enough to emerge. In this plenary I will give my historical and technical point of view on the question whether there are still significant open scientific problems in robotic drones and UAV research from the design and formal control perspective and I will try to critically rank such open problems in terms of difficulty and provide possible technical directions to explore the paths toward their solutions.

Biography

Antonio Franchi holds a joint appointment as full professor in aerial robotics control at the University of Twente (EEMCS Faculty, RAM department), Enschede, The Netherlands, and full professor at the Sapienza University of Rome (DIAG department), Rome, Italy. He is an IEEE Fellow. His research works are in the robotics area, with a special regard to control and estimation problems and applications ranging across motion and physical interaction control, decentralized control/estimation/ coordination, haptics, and hardware/software architectures. His main areas of expertise are aerial robotics and multiple-robot systems. He published more than 170 papers in international journals, books, and conferences and gave more than 100 invited talks in international venues. He has received awards for his published research work, PhD mentoring, and societal services by the international robotics scientific community. He has served in the editorial boards of IJRR, IEEE T-RO, IEEE RA-M, IEEE ICRA, IEEE/RSJ IROS, IEEE AES-M. He is the co-founder and emeritus co-chair of the IEEE RAS Technical Committee on Multiple Robot Systems. He has been PI in several projects focused on aerial robots and multi-robots, such as, e.g., the EU Horizon AutoAssess project, the EU H2020 Aerial-CORE project, the EU H2020 AEROARMS project, the ANR PRC 'The Flying Co-worker' and the JCJC ANR MuRoPhen project.

Maria Gini

The many facets of allocation of tasks to robots

How many robots would you want to use if you had multiple robots working for you? Does the answer depend on the tasks you will assign to them? Are the tasks independent of each other so they can be done in parallel with no coordination, or must some tasks be completed before others? Do the robots need a central controller to coordinate their work, or can each robot work independently? Can robots use a model of decentralized coordination? These are central research questions that I will address in the talk. Of special interest are methods that can be used for tasks that have temporal and precedence constraints. In this talk, I will present examples of task allocation problems in multiple contexts, some requiring planning in advance and some requiring decisions in real-time. I will conclude with a discussion of the major open issues in multi-robot systems.

Biography

Maria Gini is a College of Science and Engineering Distinguished Professor in the Department of Computer Science and Engineering at the University of Minnesota. She works on decision-making for autonomous agents and robots. Her work ranges from distributed methods for allocation of tasks to robots, control of large swarms of robots, teamwork for search and rescue, navigation in dense crowds, and, more recently, conversational agents for the elderly. She has won numerous awards for increasing the participation of women and underrepresented minorities in computing, mentoring students and colleagues, and service to the AI community. She is a Fellow of the AAAI, ACM, and IEEE. She is Co-Editor in Chief of Robotics and Autonomous Systems and is on the editorial board of other journals, including Autonomous Agents and Multi-Agent Systems, Current Robotics Reports, and Integrated Computer-Aided Engineering.

Ken Goldberg

Is Data All You Need? Large Robot Action Models and Good Old Fashioned Engineering

2024 is off to an exciting start with enormous enthusiasm for humanoids and other robots based on recent advances in "end-to-end" large robot action models. Initial results are promising, and several collaborative efforts are underway to collect the needed demonstration data. But is data all you need? I'll share my concerns about current trends in robot task definition, data collection, and experimental evaluation. I propose that to reach expected performance levels, we'll need "good old fashioned engineering" – modularity, algorithms, and metrics. Like biological brains, which evolved to be modular rather than monolithic, we need systematic approaches to combine GOFE and learning. I'll present MANIP, a new framework that integrates engineering / modularity with learning, that we've applied to robot tasks such as cable untangling, surgical suturing, and bagging.

Biography

Ken Goldberg is William S. Floyd Distinguished Chair of Engineering at UC Berkeley and Chief Scientist of Ambi Robotics and Jacobi Robotics. Ken leads research in robotics and automation: grasping, manipulation, and learning for applications in warehouses, industry, homes, agriculture, and robot-assisted surgery. He is Professor of IEOR with appointments in EECS and Art Practice. Ken is Chair of the Berkeley AI Research (BAIR) Steering Committee (60 faculty) and is co-founder and Editor-in-Chief emeritus of the IEEE Transactions on Automation Science and Engineering (T-ASE). He has published ten US patents, over 400 refereed papers, and presented over 600 invited lectures to academic and corporate audiences.

Yi Guo

Bridging Model-Based and Learning-Based Control Methods for Autonomous Mobile Robotic Systems

Autonomous mobile robotic systems have been widely used in real-world applications, from environmental monitoring tasks to tasks where robots assist humans in social settings. Motion control is fundamental to autonomous mobile robotic systems, and the methods have evolved from model-based methods (that rely on physical models of the robot and its operating environment) to machine learning based methods (that use data generated by the robot while interacting with the environment). In this talk, I will discuss both model-based control and learning based control, and present their applications in controlling autonomous surface vehicles for dynamic plume tracking and controlling autonomous ground vehicles for pedestrian flow optimization. I will then present comparisons of the two different types of methods, in a case study to solve the problem of multi-robot decentralized triangulation. Advantage and limitation of each method will be discussed, and insights toward integrating physics-based methods with data-based methods will be provided.

Biography

Yi Guo joined the Department of Electrical and Computer Engineering at Stevens Institute of Technology in 2005, and is currently Thomas E. Hattrick Chair Professor. Before 2005, she was a Visiting Assistant Professor in the ECE Department of the University of Central Florida. Dr. Guo received her Ph.D. degree in Electrical and Information Engineering in 1999 from the University of Sydney, Australia. After her Ph.D, she worked as a postdoctoral research fellow at Oak Ridge National Laboratory for two years. Dr. Guo's research interests are mainly in distributed and collaborative robotic systems, human-robot interaction, and dynamic systems and controls. She authored one book, edited one book, and published over 150 journal and conference papers. She is currently the Editor-in-Chief of the IEEE Robotics and Automation Magazine. She was Associate Editor of IEEE Robotics and Automation Letters, IEEE/ASME Transactions on Mechatronics, and IEEE Access. Her awards include Best Application Paper Award at WCICA2018, and Provost's Award for Research Excellence at Stevens. She serves in ASME Dynamic Systems and Control Division (DSCD) Honors and Awards Committee, IEEE Robotics and Automation Society (RAS) Committee to Aid Reporting on Misconduct Concerns (CARES). She served in Organizing Committees of the premier robotics conference ICRA and IROS. She is Distinguished Lecturer of IEEE RAS.

Gregory Hager

Toward Flexible Vision-Enabled System for the Physical World: Are We There Yet?

Efforts to develop vision-based robotic systems date back the beginnings of AI and continue to this day. Along the way there have been many notable achievements, beginning with very task-specific vision-based control methods requiring special-purpose hardware, and steadily building toward more general and capable systems. However, until the advent of deep learning, the idea of general-purpose vision-based robotics was limited by the lack of visual recognition capability. This has been transformed over the past decade by increasingly capable and efficient deep learning systems. In this talk, I'll briefly review some of the early progress and limiting factors in vision-based robotics, and then will turn to a discussion of modern vision-driven systems, drawing on my experience with both vision-based robotics and the development of real-world deployments of Just Walk Out technology in Amazon physical stores as well as my own research. I'll close with some thoughts on the intrinsic limitations of today's ML-based and some speculation on what the next necessary advances will be.

Biography

Gregory D. Hager is the Mandell Bellmore Professor of Computer Science at Johns Hopkins University and the Assistant Director for Computer and Information Science and Engineering at the National Science Foundation. Previously, he was a Director of Applied Science within Amazon's Just Walk Out Technology organization, a Senior Applied Scientist in Amazon Robotics, and the Founding Director of the Malone Center for Engineering in Healthcare at JHU. His research interests include computer vision, collaborative and vision-based robotics, time-series analysis of image data, and medical applications of image analysis and robotics. He has published over 500 articles, books, and book chapters in these areas. He has been a visiting professor at the Technical University of Munich and Stanford University. Professor Hager is a fellow of the ACM and IEEE for his contributions to Vision-Based Robotics, a Fellow of the MICCAI Society and of AIMBE for his contributions to imaging and his work on the analysis of surgical technical skill, and a Fellow the AAAS for his contributions to vision-based robotics and computer-enhanced interventional medicine.

Thomas C. Henderson

Safe UAS Traffic Management in the Context of Urban Air Mobility

Many countries are developing an Urban Air Mobility (UAM) capability defining an Unmanned Aircraft Systems (UAS) Traffic Management (UTM) architecture to allow safe UAS services (e.g., delivery, inspection, air taxis, etc.) in urban environments. The main considerations are air worthiness, operator certification, air traffic management, C2 Link, detect and avoid (DAA), safety management, and security. A lane-based airspace structure is described here which reduces the complexity of strategic deconfliction by providing UAS agents with a set of pre-defined airway corridors called lanes. This yields collateral benefits including UAS information privacy, robust contingency handling, as well as improved observability and control of the air space. The major results are: (1) the creation and layout of lane structures, (2) an efficient lane-based strategic deconfliction scheduling algorithm, (3) lane-network performance analysis tools, and (4) tactical deconfliction for dynamic contingencies. The lack of safety guarantees has prevented the realization of Urban Air Mobility. We propose the DAIS toolkit as a meta-level formal methods approach to address this problem. The three major components are (1) an Interlocutor Agent (IA) which exploits an informed LLM to supervise the construction of a complex UAS Traffic Management (UTM) system based on natural language dialog with the design team, (2) formal methods to address the integration of requirements across a set of diverse components, and (3) a proof-of-concept testbed for the analysis of UTM performance.

Biography

Thomas C. Henderson is a full professor in the School of Computing at the University of Utah; he has been a visiting professor at DLR and the University of Karlsruhe in Germany, and at INRIA (Rocquencourt and Sophia Antipolis) in France, and a Program Director at the National Science Foundation where he helped launch the National Robotics Initiative. His general research interests include autonomous cognitive systems, robotics and computer vision, and one current major goal is to help realize safe operational UAS Traffic Management systems, and Lane-Based Unmanned Aircraft Systems Traffic Management (Springer 2022) is a recent publication on this topic. Prof. Henderson has served as Co-Editor-in-Chief of the Journal of Robotics and Autonomous Systems and as an Associate Editor for the IEEE Transactions on Pattern Analysis and Machine Intelligence and IEEE Transactions on Robotics and Automation. He is a Fellow of the IEEE and received the Utah Governor's Medal for Science and Technology in 2000. He enjoys good dinners with friends, reading, playing basketball and hiking.

Josie Hughes

Towards Robust Robots by Building Embodied Intelligence

To develop robust robots for manipulation, locomotion and more we need to understand how to leverage principles of Embodied Intelligence from bio-inspiration, and combine them with advances in AI and control in a synergistic way. This talk will explore a number of approaches to designing and fabricating robots that can robustly interact with the environment with a focus on anthropomorphic manipulation and multi-modal locomotion and swimming. The applications and new capabilities enabled by these robots will be discussed, with a focus on sustainability and agricultural applications.

Biography

Josie Hughes is an Assistant Professor at EPFL where she established the CREATE Lab in the Institute of Mechanical Engineering in 2021. She undertook her undergraduate, masters and PhD studies at the University of Cambridge, joining the Bio-inspired Robotics Lab (BIRL). Her PhD focused on examining the role of passivity in bio-inspired manipulators, and methodologies for exploiting morphology of soft large area soft sensing. Following this, she worked as a postdoctoral associate at the Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology in the USA in the Distributed Robotics Lab. Her research focuses on developing novel design paradigms for designing robot structures that exploit their physicality and interactions with the environment. This includes the development of robotic hands, soft manipulators and automation systems for applications focused on sustainability and science. She has a number of best paper awards and was awarded the IEEE RAS Early Career Award in 2024.

Lydia Kavraki

30 Years of Sampling-based Motion Planners: from Minutes to Microseconds

Classical path planning in robotics addresses the problem of finding a collision-free path from a start to a goal configuration in a known environment. Thirty years ago, in 1994, the publication of the Probabilistic Roadmap Planner at ICRA introduced sampling-based planners and marked a paradigm shift in the field. This innovation laid the groundwork for efficient and effective methods capable of solving complex problems involving mobile and articulated robots in challenging environments. In this talk, we will celebrate the contributions of numerous researchers to this motion planning paradigm. I will highlight the enduring advantages of these planners. Then, I will describe recent advancements that leverage this paradigm and achieve planning times in the microsecond range and solution rates in the kilohertz range, all without specialized hardware. These advancements extend to sensed environments, broadening the use of planning for high-dimensional systems in dynamic, evolving, and unmodeled contexts. I will conclude with a discussion on using planning as a module for complex long-horizon reasoning in robotics and the challenges that lie ahead.

Biography

Lydia Kavraki is the Noah Harding Professor of Computer Science at Rice University. She also holds joint appointments in Electrical & Computer Engineering, Mechanical Engineering, and Bioengineering and serves as the Director of the Ken Kennedy Institute at Rice University. Kavraki received her B.A. in Computer Science from the University of Crete, Greece, and her Ph.D. in Computer Science from Stanford University under the supervision of Professor Jean-Claude Latombe. Her research focuses on developing methodologies that enable robots to collaborate and support humans. This includes creating algorithms for motion planning in high-dimensional spaces with kinematic and dynamic constraints, designing integrated frameworks for reasoning under uncertainty, developing novel methods for learning and for using experiences, and ways to instruct robots at a high level and interact with them. Her research group has also produced the Open Motion Planning Library (OMPL), a widely used open-source library of motion planning algorithms. Outside robotics, she has devised a robotics-engineering approach to the analysis of biomolecular interactions, with significant contributions in structural computational biology. Kavraki is an associate editor for Science Robotics, PNAS Nexus, and the Annual Review of Control, Robotics, and Autonomous Systems. She has received numerous awards, including the IEEE Robotics Pioneer Award and the IEEE Frances E. Allen Medal. She is a Fellow of ACM, IEEE, AAAS, AAAI, AIMBE, and a member of the American Academy of Arts and Sciences.

Oussama Khatib

The Journey of Robotics

Robots today are making significant inroads into many aspects of modern life, from their initial roots in industrial manufacturing moving now into healthcare, transportation, logistics, and exploration of deep space and the oceans. This chapter sketches the fascination of this field and its evolution from ancient to modern times. The journey takes us through numerous milestones: from the first automated mechanical artifact (1400 BC) through the establishment of the robot concept in the 1920s, the realization of the first industrial robots in the 1960s, the definition of robotics science and the birth of an active research community in the 1980s, and the expansion into the challenges of our modern twenty-first-century world.

Biography

Oussama Khatib received his PhD from Sup'Aero, Toulouse, France, in 1980. He is Professor of Computer Science and Director of the Robotics Laboratory at Stanford University. His research focuses on methodologies and technologies in human-centered robotics, haptic interactions, artificial intelligence, human motion synthesis and animation. He is President of the International Foundation of Robotics Research (IFRR) and an IEEE Fellow. He is Editor of the Springer STAR and SPAR series, and Springer Handbook of Robotics. He is recipient of the IEEE Robotics and Automation, Pioneering Award, the George Saridis Leadership Award, the Distinguished Service Award, the Japan Robot Association (JARA) Award, the Rudolf Kalman Award, and the IEEE Technical Field Award. Professor Khatib is Knight of the National Order of Merit and a member of the National Academy of Engineering.

Abderrahmane Kheddar

Are Humanoids Ready for the Job?

Recently, we are witnessing a booming in humanoid robotics, and rapid advancements in their hardware and embedded software capabilities and intelligence. From initial applications in entertainment and disaster operations to recent strides in large-scale manufacturing and domestic assistance for frail people, humanoids are poised to revolutionize various industries and social services. My talk reports results from our pioneering research work in possible deployment of humanoid robots in large-scale industries and human physical assistance for frail persons through representative use-cases. I will highlight the gaps to overcome, from a research and development perspective, to meet such visionary expectations. My talk also questions how the humanoid academic research should position itself with respect to humanoids private R&D sectors, emerging SMEs, and industries which are widening unbridgeable gap with technological advances, some of which seem to be beyond the reach of academic centers.

Biography

Abderrahmane Kheddar received the B.S. degree in computer science from the Institut National d'Informatique, Algiers, Algeria, in 1990, and the M.Sc. and Ph.D. degrees in robotics from Sorbonne University, Paris, France in 1993 and 1997, respectively. From 1998 to 2003, he was successively Assistant, Associate and Full Professor at the University of Evry, Paris Sorbonne and took a secondment position at CNRS in 2004 to joint AIST in Japan as a codirector of the Joint Japanese-French Robotic Laboratory. In 2008, he created the CNRS-AIST Joint Robotic Laboratory, Tsukuba, Japan, as a full-flagged international laboratory where he was the director from 2008 to 2016 and codirector from 2017 to 2021. In 2010 he created in parallel the Interactive Digital Humans team and led it until 2020, with the University of Montpellier. His research interests include haptics, humanoids, and related bionics. He is a Founding Member of the IEEE Robotics and Automation Society (RAS) Chapter on Haptics, and the Co-Chair and Founding Member of the IEEE RAS Technical Committee on Model-Based Optimization. He is a Member of the Steering Committee of the IEEE Brain Initiative. Since 2020 he is the lead of bionics at CARTIGEN, University Hospital of Montpellier. He is a Fellow of the IEEE, a Fellow of the Asia-Pacific Artificial Intelligence Association and Vice-President of the International Artificial Intelligence Industry Alliance (AIIA). He is a Full Member of the National Academy of Technology of France and a Knight of the National Order of Merits of France.

Sangbae Kim

Physical intelligence and Cognitive Biases Toward AI

When will robots be able to clean my house, dishes, and take care of laundry? While we source labor primarily from automated machines in factories, the penetration of physical robots in our daily lives has been slow. What are the challenges in realizing these intelligent machines capable of human level skill? Isn’t AI advanced enough to replace many skills of humans? Unlike conventional robots, which are optimized mainly for position control with almost no adaptability, household tasks require a kind of 'physical intelligence' that involves complex dynamic interactions with overwhelming uncertainties. While advanced language models exemplify AI's prowess in data organization and text generation, a significant divide exists between AI for virtual and physical applications. In this conversation, we'll delve into the cognitive biases that often lead us to underestimate this technological gap.

Biography

Sangbae Kim is the director of the Biomimetic Robotics Laboratory and a professor of Mechanical Engineering at MIT. His research focuses on bio-inspired robot development achieved by extracting principles from animals. Kim's achievements include creating the world's first directional adhesive inspired by gecko lizards and a climbing robot named Stickybot that utilizes the directional adhesive to climb smooth surfaces. One of Kim's recent achievements is the development of the MIT Cheetah, a robot capable of stable running outdoors up to 13 mph and autonomous jumping over obstacles at the efficiency of animals. Kim is a recipient of best paper awards from the ICRA (2007), King-Sun Fu Memorial TRO (2008) and IEEE/ASME TMECH (2016). Additionally, he received a DARPA YFA (2013), an NSF CAREER award (2014), a Ruth and Joel Spira Award for Distinguished Teaching (2015) and Nagamori Award (2023). He is a member of DSSG (Defense Science Study Group) 2019~2024. He gave talks at prestigious meetings such as TED xMIT, DAVOS economic Forum, Amazon MARS meetings, and Keynote speech at IROS2019.

Jens Kober

Robots Learning Through Interactions

The acquisition and self-improvement of novel motor skills is among the most important problems in robotics. A human teacher is always involved in the learning process, either directly (providing data) or indirectly (designing the optimization criterion), which raises the question: How to best make use of the interactions with the human teacher to render the learning process efficient and effective? In this talk I'll argue that there are tremendous benefits in having a human teacher intermittently interact with a robot also while it is learning. I will discuss various methods in the fields of imitation learning, reinforcement learning, and interactive learning. All these concepts will be illustrated with real robot experiments ranging from fun to more applied. I will conclude with a discussion of the major challenges and the potential impact of the concept of robots learning in interaction with human teachers holds for the future.

Biography

Jens Kober is an associate professor at the TU Delft, Netherlands. He worked as a postdoctoral scholar jointly at the CoR-Lab, Bielefeld University, Germany and at the Honda Research Institute Europe, Germany. He graduated in 2012 with a PhD Degree in Engineering from TU Darmstadt and the MPI for Intelligent Systems. For his research he received the annually awarded Georges Giralt PhD Award for the best PhD thesis in robotics in Europe, the 2018 IEEE RAS Early Academic Career Award, the 2022 RSS Early Career Award, and has received an ERC Starting grant. His research interests include motor skill learning, (deep) reinforcement learning, imitation learning, interactive learning, and machine learning for control.

Jana Kosecka

Finding objects in the era of large vision and language models

Locating and moving toward objects in both familiar and unfamiliar environments is a fundamental function of mobile agents. The decision-making process requires developing strategies that balance navigation and exploration in new settings. Perception plays a crucial role in identifying objects of interest based on natural language descriptions, including nouns, complex referring expressions, and spatial relationships with other objects. I will present a method for utilizing readily available large vision and language models to achieve high-fidelity semantic representations of environments. Additionally, I will explore the opportunities and challenges associated with using these models to understand spatial relationships. Finally, I will discuss how these improved perceptual capabilities can be applied to tasks involving object search and vision-language navigation.

Biography

Jana Kosecka is a Professor at George Mason University at the Department of Computer Science. Her research areas are Computer Vision, Robotics and Embodied AI. She focuses on 'seeing' systems engaged in autonomous tasks, the acquisition of static and dynamic models of environments by means of visual sensors and human-robot-computer interaction. She has over 200 publications in refereed journals and conferences and is a co-author of a monograph titled Invitation to 3D vision: From Images to Geometric Models. Prof. Kosecka is an Associate Editor in Chief of IEEE Transactions of Pattern Recognition and Machine Analysis, is a former chair of the IEEE RAS Technical Committee of Robot Perception, Associate Editor of IEEE Robotics and Automation Letters and International Journal of Computer Vision. She has held visiting positions at Stanford University, Google, and Nokia Research. Prior to joining George Mason, she was a postdoctoral fellow at the EECS Department at University of California, Berkeley, affiliated with Robotics Laboratory and PATH and earned her Ph.D. in Computer Science from the University of Pennsylvania, Philadelphia. Prof. Kosecka has received the Marr Prize in Computer Vision and a National Science Foundation CAREER Award.

Katherine J. Kuchenbecker

Haptic Intelligence

Touch is far less understood than vision or hearing, since what you feel greatly depends on how you move, and since engineered haptic sensors, actuators, and algorithms typically struggle to match human capabilities. My team and I work to sharpen our understanding of haptic interaction by investigating the dual approaches of haptic interfaces and autonomous robots. Haptic interfaces are mechatronic systems that modulate the physical interaction between a human and their tangible surroundings. Typically taking the form of grounded kinesthetic devices, ungrounded wearable devices, or surface devices, such systems enable the user to act on and feel a remote or virtual environment. I will elucidate key approaches to creating outstanding haptic interfaces by showcasing examples of my research on both kinesthetic and wearable devices. Then I will draw parallels to autonomous robots, where the engineered system acts as an agent rather than a tool and needs to detect and intelligently react to (rather than generate) haptic signals. In addition to inventing tactile sensors and touch-processing approaches, we have created several physically interactive robots, including HuggieBot, a custom robot that uses real-time haptic sensing to give good hugs.

Biography

Katherine J. Kuchenbecker is a Director at the Max Planck Institute for Intelligent Systems (MPI-IS) in Stuttgart, Germany, and an Honorary Professor at the University of Stuttgart. She earned her Ph.D. in Mechanical Engineering with Günter Niemeyer at Stanford University in 2006, did postdoctoral research with Allison M. Okamura at the Johns Hopkins University, and was an engineering professor in the GRASP Lab at the University of Pennsylvania from 2007 to 2016. Her research blends haptics, teleoperation, physical human-robot interaction, tactile sensing, and medical applications. She delivered a TEDYouth talk on haptics in 2012 and has been honored with a 2009 NSF CAREER Award, the 2012 IEEE RAS Academic Early Career Award, a 2014 Penn Lindback Award for Distinguished Teaching, elevation to IEEE Fellow in 2021, and 19 best paper, poster, demonstration, and reviewer awards. 18 of the postdocs and doctoral students she has mentored have become faculty members around the world. She co-chaired the IEEE Haptics Symposium in 2016 and 2018 and is Editor-in-Chief of the 2025 IEEE World Haptics Conference. She has led her institute's main doctoral program, the International Max Planck Research School for Intelligent Systems (IMPRS-IS), since its founding in 2017 and advocates passionately for gender equality, diversity, equity, and inclusion.

James Kuffner

Building Safe Intelligent Machines

Robust, capable, intelligent automated systems of the future can be realized by combining the safety of model-based design with the scalability of data-driven algorithms. High-performance networking, artificial intelligence (AI), and cloud computing are radically transforming all aspects of human society and are poised to disrupt the state-of-the-art in the development of intelligent machines. For robot systems and automotive products to be viable in the market, model-based designs with functional safety are incorporated to provide explainability and minimize risks to people's lives. However, increasingly complex models of intelligent behavior are often difficult or impossible to manually design. This talk will explore methods to combine the best of both data-driven and analytical modeling techniques to create safe, superior performance intelligent machines - technology products whose ultimate purpose is to support human happiness and well-being.

Biography

James Kuffner is a Senior Fellow at Toyota Motor Corporation best known for his work on Rapidly-exploring Random Trees (RRTs) for robot motion planning. His work spans both academic research and industrial technology deployment of autonomous systems, including humanoid robots and automated driving. He received a Ph.D. from the Stanford University Dept. of Computer Science Robotics Laboratory in 2000, and was a Japan Society for the Promotion of Science (JSPS) Postdoctoral Research Fellow at the University of Tokyo. He joined the faculty at Carnegie Mellon University's Robotics Institute in 2002. Kuffner was a Research Scientist and Engineering Director at Google from 2009 to 2016. He was part of the initial engineering team that built Google's self-driving car. In 2010, he introduced the term "Cloud Robotics" to describe how network-connected robots could take advantage of distributed computation and data stored in the cloud. He was appointed head of Google's Robotics division in 2014. He Joined the Toyota Research Institute (TRI) as CTO in 2016. He continues to serve as an Adjunct Associate Professor at the Robotics Institute, Carnegie Mellon University, and as an Executive Advisor to TRI.

Yasuo Kuniyoshi

From Embodiment to Super-Embodiment: An Approach to Open-Ended and Human Aligned Intelligence/Mind

Embodiment is crucial for resolving the reliability and alignment challenges in contemporary AI. This is because it imposes consistent constraints on the entire agent-environment interactions and generate information structures without specifying their actual contents, and the constraints are common to those with similar embodiment. This concept must extend beyond mechanical properties and sensory information structure to include internal organs, metabolism, mental processes, and inter-agent interactions, evolving into "super-embodiment." Super-embodiment can address sensibilities, values, and morals, aligning AI with humans toward artificial humanity. This talk will demonstrate the emergence and development of behaviors and cognition from this extended embodiment framework through experiments with embodied models, including a simulated fetus and internal organs. Super-embodiment lays the groundwork for the next generation of artificial general intelligence (AGI) that can operate effectively in unpredictable environments while adhering to human values.

Biography

Yasuo Kuniyoshi received Ph.D. from The University of Tokyo in 1991 and joined Electrotechnical Laboratory, AIST, MITI, Japan. From 1996 to 1997 he was a Visiting Scholar at MIT AI Lab. In 2001 he was appointed as an Associate Professor and then full Professor in 2005 at The University of Tokyo. He is also the Director of RIKEN CBS-Toyota Collaboration Center (BTCC) since 2012, the Director of Next Generation Artificial Intelligence Research Center of The University of Tokyo since 2016, and an affiliate member of International Research Center for Neurointelligence (IRCN) of The University of Tokyo since 2018. He published over 300 refereed academic papers and received IJCAI 93 Outstanding Paper Award, Gold Medal "Tokyo Techno-Forum21" Award, Best Paper Awards from Robotics Society of Japan, IEEE ROBIO T.-J. Tarn Best Paper Award in Robotics, Okawa Publications Prize, and other awards. He is a Fellow of Robotics Society of Japan, President of the Japan Society of Developmental Neuroscience, and a member of IEEE, Science Council of Japan (affiliate), Japan Society of Artificial Intelligence, Information Processing Society of Japan, Japanese Society of Baby Science.

Dong-Soo Kwon

Robotic Ureteroscopy System: from Research to Commercialization

The successful use of the da Vinci system in laparoscopic surgeries has demonstrated the benefits of robotic assistance, such as precision and ergonomic manipulation. This trend towards minimally invasive and non-invasive surgeries is driven by innovative surgical robots, especially flexible endoscopic robots. This talk focuses on the robotic ureteroscopy system "ZAMENIX," an endoluminal non-invasive surgery robot for kidney stone treatment. Zamenix allows the precise and stable teleoperation of a flexible ureteroscope, laser fiber, and stone basket, offering options for laser dusting or stone retrieval. It provides intuitive remote manipulation without the need for an X-ray protection gown and includes features such as automation of repetitive tasks, detection of oversized stones, and respiratory motion compensation by AI technology. A successful first-in-human trial in Korea showed high efficacy and safety. The commercialization journey of medical devices involved overcoming challenges related to regulatory approvals, safety tests, documentation, funding, obtaining a reimbursement code, manufacturing, and sales. The author wishes Zamenix's experience to inspire robotic researchers to pursue the commercialization of their valuable research results.

Biography

Dong-Soo Kwon is Emeritus Professor of the Department of Mechanical Engineering of KAIST and CEO of ROEN Surgical, Inc. He received the B.S. degree in 1980 from Seoul National University, the M.S.E. degree in 1982 from KAIST and the Ph.D. degree in 1991 from Georgia Institute of Technology, USA. He has been the vice President of Korean Innovative Medical Technology Society since 2019, is a Senior member of IEEE, Honorary chairman of the Korean Society of Medical Robotics, Honorary Chair of IEEE Ro-MAN 2023, and was President of Asian Society of Computer Aided Surgery (ASCAS), the program Chair of IEEE/RSJ international Conference on Intelligent Robots and Systems 2016, an academician at the National Academy of Engineering of Korea (NAEK).

He received the 2023 Distinguished Service Award from the IEEE Robotics and Automation society, EAU2023 Best Video Abstract Awards First Prize, IROS Harashima Awards of Innovative Technologies in 2022, Top 10 Mechanical Engineering Technology of the Year 2019 from KFMES, Best Application Award and overall winner from Hamlyn Surgical Robot Challenge 2018, and the Harashima Mechatronics Award from ICROS 2009 and JTCF Novel Technology Paper Award from Amusement Culture from IROS in 2010. He also received the double Korea Presidential Commendation (2018, 2022).

Steven M. LaValle

Planning Algorithms: Past, Present, and Possible Future

It has been 40 years since the first ICRA, and 20 years since I wrote my Planning Algorithms book, which has been freely available online and widely used by students and educators around the world. It covers time-tested fundamentals for computing autonomous motions of robots. In this talk, I will summarize the perspective I gained in 2004 while developing unified coverage of topics such as sampling-based motion planning, reinforcement learning, nonholonomic planning, discrete planning, feedback planning, optimal control, and game theory. Within this framework, I will summarize major advances that have been made over the subsequent two decades, including asymptotically optimal planning, deep reinforcement learning, and information spaces. The talk will conclude with some reflections on changing research culture over the past few decades and the identification of future challenges and opportunities in the broad area of planning algorithms or whatever it may evolve into.

Biography

Steven M. LaValle has been Professor of Computer Science and Engineering, in Particular Robotics and Virtual Reality, at the University of Oulu, Finland since 2018. Since 2001, he has also been a professor in the Department of Computer Science at the University of Illinois. He has previously held positions at Stanford University and Iowa State University. His research interests include robotics, virtual and augmented reality, sensing, planning algorithms, computational geometry, and control theory. In research, he is most known for the introduction of the Rapidly exploring Random Tree (RRT) algorithm, which is widely used in robotics and other engineering fields. In industry, he was an early founder and chief scientist of Oculus VR, acquired in 2014 by Facebook for $3 billion, where he developed patented tracking technology for consumer virtual reality and led a team of perceptual psychologists to provide principled approaches to virtual reality system calibration, health and safety, and the design of comfortable user experiences. From 2016 to 2017 he was Vice President and Chief Scientist of VR/AR/MR at Huawei Technologies, Ltd. Since 2014, he has been an angel investor and startup advisor. He has authored the books Planning Algorithms, Virtual Reality, and Sensing and Filtering. He currently leads an Advanced Grant project from the European Research Council on the Foundations of Perception Engineering.

Dongheui Lee

Human-Centric Approaches for Robot Learning and Interaction with Human

The robotics research community has shown increased interest in robot skill learning in the past decade. Robot learning from imitating successful human demonstrations provides an efficient way to learn new skills and an intuitive way to program a robot, which can reduce the time and cost of programming the robot. Beyond learning simple movement primitives, the learning from demonstrations can be utilized further in the research direction of continual learning and natural human-robot interaction. In this talk, I will review some of the background, motivations, and state of the art in the field of robot learning from demonstrations. The presented applications range from complex task learning to human assistance. I will introduce some of the recent progress that we made in our lab for bridging the low-level skill learning and task knowledge.

Biography

Dongheui Lee is full Professor of Autonomous Systems at TU Wien, Austria since 2022. She is also leading the Human-Centered Assistive Robotics group at the German Aerospace Center (DLR) since 2017. Her research interests include human motion understanding, human-robot interaction, machine learning in robotics, and assistive robotics. Prior to her appointment at TU Wien, she was an Assistant Professor and Associate Professor at the Technical University of Munich (TUM), a Project Assistant Professor at the University of Tokyo, and a research scientist at the Korea Institute of Science and Technology (KIST). She obtained a PhD degree from the Department of Mechano-Informatics, University of Tokyo in Japan. She was awarded a Carl von Linde Fellowship at the TUM Institute for Advanced Study and a Helmholtz professorship prize. She has served as Senior Editor and a founding member of IEEE Robotics and Automation Letters (RA-L) and Associate Editor for the IEEE Transactions on Robotics.

Zexiang Li

From Robotics competition to education innovation and startups

As is well known, being able to understand the user's needs and come up with a sound product concept is a key challenge for most startups. Being in the Greater Bay Area (GBA) for more than thirty years and working with more than one hundred startups in various capacities, we know that this is also not an easy job for a GBA startup as well.

In this talk, I will describe our journey to develop a startup ecosystem in the GBA of China. In 1999, with the setup of the HKUST IER platform in Shenzhen, we founded Googol Tech, which is now a leading motion control company in China. In 2004, we introduced a project course in robot design through which students are empowered with not only hands-on and teamwork skills, but also become familiar with the supply chain system in Shenzhen. About one third of the graduates from the Automation Technology Center (ATC) later went on to found their own companies, more than 50 in total, including DJI, QKM, ePropulsion, etc. In 2015, we founded the XbotPark Incubator in Dongguan (a GBA city north of Shenzhen) for mainly fresh graduates from colleges. More than 60 startups emerged from this program, with a survival rate of 80%, and 15% achieving unicorn (more than 1B USD valuation) or near unicorn status. In 2021, we founded the Shenzhen InnoX Academy to provide an entrepreneurship education program for UG students and PG students from a consortium of universities. An important feature of the Xbotpark ecosystem is the Shared Factory model providing a one-stop solution for startups from product R&D prototyping to NPI and to MP. Collaborating with leaders of different sectors of the OEM industry, we established an in-house process and quality assurance system, achieving critical KPIs such as time-of-response, cost and quality, etc. for our clients.

Biography

Prof. **Zexiang Li** joined the Department of Electronic and Computer Engineering of the Hong Kong University of Science and Technology and is currently a professor of the department. He founded the Automation Technology Center (ATC) and Robotics Institute (RI). He is also the founder of XbotPark and Shenzhen InnoX Academy.

Zexiang Li co-founded several companies with his colleagues and students from the Automation Technology Center, including Googol Tech (the first motion control company in China), DJI (a leading company in UAV and flycam products), QKM Tech (an automation company providing excellent robot products and services to manufacturers world-wide) and ePropulsion (an innovative provider of high-performance marine electric propulsion systems).

In 2019, Prof. Li was selected as co-recipient of the 2019 IEEE Robotics and Automation Award for his influential “contributions to the development of civilian drones, aerial imaging technology, robotics engineering advancement, innovation and entrepreneurship.” In 2020, he was awarded as an innovative and entrepreneurial figure and a model in the 40th anniversary of the establishment of Shenzhen Special Economic Zone. He was awarded the “You Bring Charm to the World Award” in 2024.

Kevin Lynch

Chasing Dexterity: Autonomous and Human-Collaborative Robot Manipulation

Despite rapid progress in AI, machine learning, and certain subfields of robotics, progress in robot dexterity has been slow. Yet the potential economic and societal impact of dexterous robotic manipulation is enormous, spanning fields such as manufacturing, warehouse logistics, elder care, space exploration, and food preparation.

In this talk I will discuss two paths toward robotic dexterity: autonomy and human-robot collaboration. Autonomy, long the default goal of manipulation researchers, raises challenges in soft materials, novel actuators, tactile sensing, machine learning, control, user interfaces, and more that necessitate a highly integrated research program. Full autonomy is a tough nut to crack. On the other hand, robots that physically collaborate with humans take advantage of the human's autonomy (e.g., adaptability and situational awareness) and can increase human productivity dramatically in the near term.

Biography

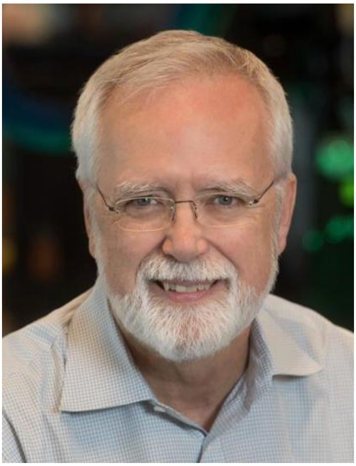
Kevin Lynch is a professor of mechanical engineering and director of the Center for Robotics and Biosystems at Northwestern University. His research is on robotic manipulation, locomotion, human-robot systems, and robot swarms. He is former Editor-in-Chief of the IEEE Transactions on Robotics and the ICRA Conference Editorial Board, coauthor of three textbooks on robotics and mechatronics, and instructor of six Coursera courses and the associated YouTube videos forming the Modern Robotics specialization. He is also a mediocre baseball coach and a wannabe educational game designer (Fossil Canyon, created with the Field Museum of Chicago). He received the B.S.E. degree in electrical engineering from Princeton University and the Ph.D. degree in robotics from Carnegie Mellon University.

Matthew Mason

Lessons from warehouse robotics: From warehouses to kitchens

When robotics research addresses an application domain, we roboticists study the domain and learn some important lessons. From manufacturing, we learned about compliant motion, mechanics of assembly, and much more. What will we learn from logistics? Logistics is about the efficient storage and transfer of goods – efficiency in space, time, and other resources. Space-efficient storage and transfer lead to levels of clutter far beyond what robotics researchers contemplated in the past. You might notice it first in warehouses, but once you are alert to it, you will see it everywhere, including your own home.

Biography



Matthew Mason is Professor Emeritus at Carnegie Mellon, and the Chief Scientist at Berkshire Grey. Matt has spent 50 years conducting research in Artificial Intelligence and Robotics, starting as a student in the MIT AI Lab where he earned the BS, MS, and PhD degrees. He spent much of his career at Carnegie Mellon University's Robotics Institute, where he was the founder and co-director of the Manipulation Laboratory, and for ten years served as the Director of the Robotics Institute. Matt's group studied the basic physics governing grasping and manipulation, and demonstrated that sophisticated grasping and manipulation can be produced by the simple and robust grippers used in industrial automation. Mason is a Fellow of the AAAI, AAAS, ACM, and IEEE, and a winner of the IEEE R&A Society's Pioneer Award, the IEEE's R&A Prize. Most recently Matt has turned his attention to logistics and warehouse robotics, Helping to produce industry-leading solutions at Berkshire Grey.

Fumitoshi Matsuno

Beyond Living Things – Bio-inspired robots and disaster response robotics

Living things that survive natural selection have adaptive skills and intelligent behavior. For example, a swarm can perform many functions that its component individuals cannot possibly accomplish alone. It is able not only to adapt to the environment, but also to construct a suitable environment for its own advantage. Living creatures have survived and been optimized by natural selection. An understanding of the functions of living things is very useful in creating new artificial robots. In our lab., we are interested in analyzing the beautiful skills and behaviors of living things, and we are trying to find solutions to the following questions, among others: Why can a living snakes move without legs?, Why do quadrupeds change their gait patterns (for example, walk, trot, gallop) depending on their speed of movement?, What is the mechanism of the flocking mechanism of birds and fish?, How can small ants build a big anthill?, etc. Based on our understanding of these phenomena, we can apply our knowledge to create of robots to solve social and industrial problems. In this talk, I will introduce our developed snake-like robots, swarm robots, modular robots and their applications to disaster response. I will discuss the major challenges of robotics in harsh environments.

Biography

Fumitoshi Matsuno is full Professor of Osaka Institute of Technology, Professor Emeritus of Kyoto University, and Deputy Director, Field of Robotics of Fukushima Institute of Research, Education and Innovation (F-REI). The F-REI is a special legal entity that was newly established by the Government of Japan in April 2023. It aims to drive the strengthening of Japan's scientific and technological capabilities and industrial competitiveness and contribute to economic growth and the improvement of people's lives. He is also Vice-President of the NPO International Rescue System Institute, and served as President of the Institute of Systems, Control, and Information Engineers and Vice-President of the Robotics Society of Japan (RSJ). His research interests lie in bio-inspired robotics, rescue robotics, control of distributed parameter system and nonlinear system, swarm intelligence, etc. His team SHINOBI got the first place of RoboCup Rescue World Competition several times. He served as a General Chair of the IEEE SSRR2011, the IEEE/SICE SII2011, SWARM2015, DARS2021, ASCC2022, etc.

Barbara Mazzolai

EcoRobots: Soft Machines for Sustainable Environmental Applications

There is an emerging trend in robotics that envisions environmentally responsible, bioinspired systems capable of adapting to unstructured urban or natural environments. These systems, referred to as 'EcoRobots,' are constructed using recyclable, biodegradable, or biohybrid materials. They are designed to mimic the adaptability of living organisms, enabling them to navigate and function effectively in complex and unpredictable environments and to seamlessly integrate into natural ecosystems. Our inspiration primarily comes from soft invertebrates such as cephalopods and earthworms, as well as plants, which exhibit remarkable adaptive capabilities through smart, effective, and efficient strategies. In this presentation, I will outline our approach to designing and developing EcoRobots. These robots can be designed for a wide range of applications, including exploration and monitoring of natural environments and infrastructures, archaeological research, space missions, and search-and-rescue operations. In addition to introducing innovative technologies, we also aim to engage in "reverse biology" by using bioinspired robots as experimental tools to investigate biological behaviors.

Biography

Barbara Mazzolai is the Associate Director for Robotics and the Director of the Bioinspired Soft Robotics Laboratory at the Istituto Italiano di Tecnologia (IIT) in Genoa. Her research focuses on bioinspired soft robotics, blending biology and engineering to drive innovation. She has coordinated several EU-funded projects, including PLANTOID, GrowBot, and I-SEED, and started her ERC Consolidator Grant, "I-Wood," in May 2021, focusing on Forest Intelligence and robotic networks inspired by the Wood Wide Web. Barbara is the author and co-author of more than 260 papers published in international journals, books, and conference proceedings. She is a member of the Scientific Advisory Board (SAB) of the Max Planck Institute for Intelligent Systems (Tübingen and Stuttgart, Germany), the SAB of the Max Planck Queensland Centre (MPQC) for the Materials Science of Extracellular Matrices, and the Advisory Committee of the Cluster on Living Adaptive and Energy-autonomous Materials Systems (Freiburg, Germany). Currently, she is a member of the Administrative Committee (AdCom) of the IEEE Robotics and Automation Society, and Deputy Editor-in-Chief of the Soft Robotics Journal. From 2024, she is a contract professor for a course in Soft Robotics in the Department of Mechanics at the Polytechnic of Milan. In 2017, she was a Visiting Faculty at the Aerial Robotics Lab, Department of Aeronautics, at Imperial College London.

Giorgio Metta

Building components of human-robot interaction on the iCub humanoid robot

Human-robot collaboration is a challenging task that requires developing artificial perceptual skills to interpret human behaviors and exquisite timing to react seamlessly to such behaviors. One of the main goals of human-robot collaboration is to achieve a shared understanding of the task and the environment, as well as a mutual adaptation of behaviors and goals. In this talk, I will present two aspects of human-robot collaboration that can be generically understood as the “social” and the “physical” domain of interaction. All experiments are carried out on the iCub humanoid robot, a platform that offers rich perceptual and motor capabilities. In the social domain, I describe experiments that aim to understand how human interactants interpret the behavior of the iCub in well-defined and controllable scenarios. On the other hand, in the physical domain, we develop direct sensing of human movements to integrate them in the iCub controllers.

Biography

Giorgio Metta is the Scientific Director of the Italian Institute of Technology (IIT). He holds an MSc with honors (1994) and a PhD (2000) in electrical engineering from the University of Genoa. From 2001 to 2002, he was a postdoctoral associate at the AI-Lab at the Massachusetts Institute of Technology (MIT). He worked at the University of Genoa and was Professor of Cognitive Robotics at the University of Plymouth (UK) from 2012 to 2019. From 2020 to 2021 he was Visiting Professor at the University of Manchester, UK. Giorgio Metta served as deputy scientific director of IIT from 2016 to 2019. He serves in the Board of Directors of Gefran S.p.A. and Industrie De Nora S.p.A., two listed Italian companies. Giorgio Metta's research activities are in the field of bioinspired systems and humanoid robotics, with a focus on the design of machines that can learn from experience; he has authored or co-authored more than 300 scientific publications and worked as PI on about a dozen international and industrial research projects. He has coordinated the development of the iCub robot for more than a decade, making it the de facto platform of choice for research in AI; there are currently more than 50 robots in the world, in research labs as far as Japan, China, Singapore, Germany, Spain, the UK and the US.

Yukie Nagai

Embodied Predictive Processing: New Horizons in Cognitive Developmental Robotics

Cognitive developmental robotics seeks to uncover the mechanisms of human cognitive development by replicating these processes in robots. Since 2020, the field has made significant progress, demonstrating human-like cognitive behaviors in robots. One compelling advancement is the growing focus on predictive processing, a neuroscience theory posited as a unified principle of the brain. This theory offers a clear framework for understanding perception and action through minimizing prediction errors. Our research extends this concept to embodied predictive processing, explaining both continuity and diversity in cognitive development. We propose that the brain minimizes prediction errors through multimodal sensorimotor experiences in a social environment, with a robot's physical embodiment playing a crucial role. In this talk, I will highlight our latest findings, showcasing predictive processing as a unified theory of cognitive development and its implications for the future of cognitive developmental robotics.

Biography

Yukie Nagai is a Project Professor at the International Research Center for Neurointelligence at the University of Tokyo. She earned her Ph.D. in Engineering from Osaka University in 2004, after which she worked at the National Institute of Information and Communications Technology, Bielefeld University, and then Osaka University. Since 2019, she has been leading the Cognitive Developmental Robotics Lab at the University of Tokyo. Her research encompasses cognitive developmental robotics, computational neuroscience, and assistive technologies for developmental disorders. Dr. Nagai employs computational methods to investigate the underlying neural mechanisms involved in social cognitive development. In acknowledgment of her work, she received the titles of "World's 50 Most Renowned Women in Robotics" in 2020 and "35 Women in Robotics Engineering and Science" in 2022, among other recognitions.

Yoshihiko Nakamura

Will Humanoid and AI Show a Vista of the Intelligence?

One learns a lot from literature and images. The large language models (LLMs) have already/almost devoured the literature or text and the images of the world. There would be no room to doubt the use of the LLMs to generate the "robot intelligence." It is an exciting imagination and challenge to feed the modality, that the whole-body of humanoid exhibits, to the LLMs. The fundamental question is what the essential modality of body for the emergence of intelligence is. The modality of human body is the complexity of human itself and still beyond the technology of sensing and computation. Therefore, the design of modality of the humanoid robot would be the central problem, where the top-down design is required for the bottom-up data-driven approach to the intelligence. Our questions will be:

- What is the scale of modality data required for feeding to the LLMs?
- Whether what emerges from the LLMs and the whole-body modality deserves the intelligence?
- How does the quality of intelligence differ by the different modality?
- Does the emerged robot intelligence redefine the human intelligence?

I would like to celebrate the 40th anniversary of ICRA by celebrating that we stand at the moment when the robot intelligence is emerging.

Biography

Yoshihiko Nakamura is Professor and Chair of Robotics Department, Mohamed bin Zayed University of Artificial Intelligence, Abu Dhabi, UAE. He is CEO of Kinescopic, Inc. He received Ph.D. degree in mechanical engineering from Kyoto University. He held faculty positions at Kyoto University, University of California Santa Barbara and University of Tokyo before joining MBZUAI in 2024. He is Professor Emeritus of University of Tokyo. Prof. Nakamura's fields of research are humanoid robotics, biomechanics, human digital twin and their computational algorithms. He received King-Sun Fu Memorial Best Transactions Paper Award, IEEE Transaction of Robotics and Automation in 2001 and 2002. He is also a recipient of JSME Medal for Distinguished Engineers in 2019, Pioneer Award of IEEE Robotics and Automation Society in 2021 and Tateisi Prize Achievement Award in 2022. He is Foreign Member of Academy of Engineering Science of Serbia, TUM Distinguished Affiliated Professor of Technische Universität München, Life Fellow of IEEE and Fellow of Japan Society of Mechanical Engineers, Robotics Society of Japan and World Academy of Art and Science.

Bradley J. Nelson

The Robotics Part of Micro and Nano Robots

Micro and nano robots have made great strides since becoming a focused research topic over two decades ago. Much of the progress has been in material selection, processing, and fabrication, and paths forward in developing clinically relevant biocompatible and biodegradable micro and nano robots are becoming clear. Our group, as well as others, maintain that using biocompatible magnetic composites with externally generated magnetic fields and field gradients is perhaps closest to clinical application. One of the most challenging aspects in this regard is in the development of the magnetic navigation system (MNS) that generates the fields and field gradients needed for microrobot locomotion. In this talk, I will present an overview of MNSs and show how these systems are fundamentally robotic in the way they must be designed and controlled. Decades of work in robotic manipulation can be brought to bear on this problem as we move forward in bringing MNS technology to the clinic. I will also look at recent efforts in creating more intelligent micro and nano robots that exhibit increasingly complex behaviors, some of which can even be programmed in situ. The field appears to be on the cusp of realizing the fantastic voyage.

Biography

Bradley Nelson is the Professor of Robotics and Intelligent Systems at ETH Zürich and the Chief Scientific Advisor of Science Robotics. He has forty years of experience in the field and has received several awards in robotics, nanotechnology, and biomedicine. He serves on the advisory boards of academic departments and research institutes across North America, Europe, and Asia. Prof. Nelson has been the Department Head of Mechanical and Process Engineering at ETH twice, the Chairman of the ETH Electron Microscopy Center, a member of the Research Council of the Swiss National Science Foundation, and a member of the IEEE Robotics & Automation Society Administrative Committee (Adcom) from 2011-2016. He was a member of the founding editorial boards of Science Robotics and the Annual Review of Controls, Robotics, and Autonomous Systems and an editor of IEEE Transactions on Robotics from 2010- 2015. He serves on the boards of three Swiss companies, is a member of the Swiss Academy of Engineering (SATW), and is a fellow of IEEE and ASME. Before moving to Europe, Nelson worked as an engineer at Honeywell and Motorola and served as a United States Peace Corps Volunteer in Botswana, Africa. He has also been a professor at the University of Minnesota and the University of Illinois at Chicago.

Marcia O’Malley

Haptics – Augmenting Human Performance with Touch Feedback

Haptic devices enable communication via touch, augmenting visual and auditory displays or offering alternative channels of communication when vision and hearing are unavailable. Because there are numerous types of haptic stimuli that are perceivable by users – vibration, skin stretch, pressure, and temperature, among others – haptic devices can be designed to communicate complex information through the delivery of multiple types of haptic stimuli. These multi-sensory haptic devices are often designed to be wearable, and have been developed for use in a wide variety of applications including communication, entertainment, and rehabilitation. My research group is particularly interested in applications where the provision of such feedback has a measurable impact on human performance. This talk will focus on the shift from grounded to wearable haptic devices that convey multi-sensory cues, and will survey several projects that demonstrate the potential of these devices to enhance our performance in a range of scenarios. I will conclude with a discussion of the major challenges and opportunities facing the field of haptics as we look to the next forty years.

Biography

Marcia O'Malley is the Thomas Michael Panos Family Professor in Mechanical Engineering, Computer Science, Electrical and Computer currently serving as Chair of the Department of Mechanical Engineering. She received her BS in Mechanical Engineering from Purdue University, and her MS and PhD in Mechanical Engineering from Vanderbilt University. Her research is in the areas of haptics and robotic rehabilitation, with a focus on the design and control of wearable robotic devices for training and rehabilitation. At Rice, she has been recognized with Rice's Presidential Award for Mentoring, the Graduate Student Association Faculty Teaching and Mentoring Award, and the Rice University Faculty Award for Excellence in Research, Teaching, and Service. O'Malley was a recipient of both the ONR Young Investigator award and the NSF CAREER Award. Her research has been recognized with Best Paper Awards in the IEEE Transactions on Haptics and the IEEE/ASME Transactions on Mechatronics. She is a Fellow of the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, and the American Institute for Medical and Biological Engineering.

Allison Okamura

Wearable Haptic Devices for Ubiquitous Communication

Haptic devices allow touch-based information transfer between humans and intelligent systems, enabling communication in a salient but private manner that frees other sensory channels. For such devices to become ubiquitous, their physical and computational aspects must be intuitive and unobtrusive. The amount of information that can be transmitted through touch is limited in large part by the location, distribution, and sensitivity of human mechanoreceptors. Not surprisingly, many haptic devices are designed to be held or worn at the highly sensitive fingertips, yet stimulation using a device attached to the fingertips precludes natural use of the hands. Thus, we explore the design of a wide array of haptic feedback mechanisms, ranging from devices that can be actively touched by the fingertips to multi-modal haptic actuation mounted on the arm. Our most recent design uses soft, wearable, knit textiles with embedded pneumatic actuators to enable programmable haptic display. We demonstrate how such devices are effective in virtual reality, human-machine communication, and human-human communication.

Biography

Allison Okamura is the Richard W. Weiland Professor of Engineering at Stanford University in the mechanical engineering department, with a courtesy appointment in computer science. She is Director of Graduate Studies for Mechanical Engineering at Stanford University, a deputy director of the Wu Tsai Stanford Neurosciences Institute, and a Science Fellow/Senior Fellow (courtesy) at the Hoover Institution. She is an IEEE Fellow and was previously editor-in-chief of the journal IEEE Robotics and Automation Letters. Her awards include the IEEE Engineering in Medicine and Biology Society Technical Achievement Award, IEEE Robotics and Automation Society Distinguished Service Award, and Duca Family University Fellow in Undergraduate Education. She received the BS degree from the University of California at Berkeley, and the MS and PhD degrees from Stanford University. Her academic interests include haptics, teleoperation, virtual reality, medical robotics, soft robotics, rehabilitation, and education. Outside academia, she enjoys spending time with her husband and two children, running, and playing ice hockey. For more information, please see the Collaborative Haptics and Robotics in Medicine at charm.stanford.edu

Anibal Ollero

Toward bioinspired and soft aerial robotics

Safety and time of flight are significant constraints in aerial robotics. Research is progressing to overcome these limitations. Safety is not only related to classical approaches, such as obstacle detection and avoidance but also energy absorption on impact and overall robot softness. Nature offers inspiration for the development of safe and efficient aerial robots. Thus, I will present intelligent flapping-wing robots with flying, perching and manipulation capabilities. These robots can flap their wings and glide saving significant energy compared to multi-rotors and fixed-wing aircraft with propellers and they can be also safer in interactions with humans. I will also present a new generation of multi-rotor systems with soft structures and even soft propellers. These robots can perch on the body of humans and interact safely with them. I will conclude by looking to the future and presenting research challenges to increase the impact of these aerial robots.

Biography

Anibal Ollero. Head of GRVC Robotics Lab, Univ. Seville, and Scientific Director of the Center for Aerospace Technologies (CATEC). He was full professor at the Universities of Santiago and Malaga (Spain) and a researcher at the Robotics Institute of Carnegie Mellon University (Pittsburgh, USA) and LAAS-CNRS (Toulouse, France). He authored more than 900 publications, including 9 books and more than 250 papers in journals and editor of 15 books. He led more than 190 R&I projects, including an Advanced Grant from the European Research Council, coordinated the consortium of 7 projects of the European Programs and participated in 45. He transferred technologies in 89 contracts with 49 companies and has been supervisor or co-supervisor of 51 PhD Thesis. He has been recognized with 33 awards, including the Rei Jaume I in New Technologies 2019, the Spanish National Research Award in Engineering 2021 and has been Overall Winner of the ICT Innovation Radar Prize 2017 of the European Commission. He is IEEE Fellow, co-chair of the "IEEE TC on Aerial Robotics and UAV" and coordinator of the "Aerial Robotics Topic Group" of euRobotics and was also a member of its "Board of Directors". He was a founder and president of the Spanish Society for R&D in Robotics until November 2017. He is a member of the Royal Engineering Academy of Spain and of the Royal Science Academy of Galicia. He is also "Doctor Honoris Causa" by the Univ. of Malaga.

Marco Pavone

Rethinking AV Development with AV Foundation Models

Foundation models, trained on vast and diverse data encompassing the human experience, are at the heart of the ongoing AI revolution influencing the way we create, problem solve, and work. These models, and the lessons learned from their construction, can also be applied to the way we develop a similarly transformative technology, autonomous vehicles. In this talk, I will highlight recent research efforts towards rethinking elements of an AV program both in the vehicle and in the data center, with an emphasis on (1) composing ingredients for universal and controllable end-to-end simulation, (2) architecting autonomy stacks that leverage foundation models to generalize to long-tail events, and (3) ensuring safety with foundation models in the loop.

Biography

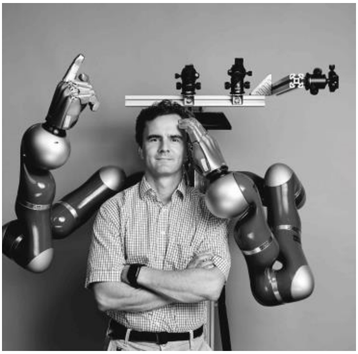
Marco Pavone is an Associate Professor of Aeronautics and Astronautics at Stanford University, where he directs the Autonomous Systems Laboratory and the Center for Automotive Research at Stanford. He also leads autonomous vehicle research at NVIDIA. Before joining Stanford, he was a Research Technologist within the Robotics Section at the NASA Jet Propulsion Laboratory. He received a Ph.D. degree in Aeronautics and Astronautics from the Massachusetts Institute of Technology in 2010. His main research interests are in the development of methodologies for the analysis, design, and control of autonomous systems, with an emphasis on self-driving cars, autonomous aerospace vehicles, and future mobility systems. He is a recipient of a number of awards, including a Presidential Early Career Award for Scientists and Engineers from President Barack Obama, an Office of Naval Research Young Investigator Award, a National Science Foundation Early Career (CAREER) Award, a NASA Early Career Faculty Award, a CSS Award for Technical Excellence in Aerospace Control, and an Early-Career Spotlight Award from the Robotics Science and Systems Foundation. He was identified by the American Society for Engineering Education (ASEE) as one of America's 20 most highly promising investigators under the age of 40. His work has been recognized with best paper nominations or awards at a number of venues, including the Computer Vision and Pattern Recognition Conference, the Conference on Decision and Control, the European Conference on Computer Vision, the IEEE International Conference on Robotics and Automation, the European Control Conference, the IEEE International Conference on Intelligent Transportation Systems, the Field and Service Robotics Conference, the Robotics: Science and Systems Conference, and the INFORMS Annual Meeting.

Jan Peters

Inductive Biases for Robot Learning

Autonomous robots that can assist humans in situations of daily life have been a long-standing vision of robotics, artificial intelligence, and cognitive sciences. A first step towards this goal is to create robots that can learn tasks triggered by environmental context or higher-level instruction. However, learning techniques have yet to live up to this promise as only few methods manage to scale to high-dimensional manipulator or humanoid robots. In this talk, we investigate a general framework suitable for learning motor skills in robotics which is based on the principles behind many analytical robotics approaches. To accomplish robot reinforcement learning from just a few trials, the learning system can no longer explore all learn-able solutions but has to prioritize one solution over others – independent of the observed data. Such prioritization requires explicit or implicit assumptions, often called ‘induction biases’ in machine learning. Extrapolation to new robot learning tasks requires induction biases deeply rooted in general principles and domain knowledge from robotics, physics and control. Empirical evaluations on a several robot systems illustrate the effectiveness and applicability to learning control on an anthropomorphic robot arm. These robot motor skills range from toy examples (e.g., paddling a ball, ball-in-a-cup) to playing robot table tennis, juggling and manipulation of various objects.

Biography



Jan Peters is a full professor (W3) for Intelligent Autonomous Systems at the Computer Science Department of the Technische Universität Darmstadt since 2011, and, at the same time, he is the dept head of the research department on Systems AI for Robot Learning (SAIROL) at the German Research Center for Artificial Intelligence (Deutsches Forschungszentrum für Künstliche Intelligenz, DFKI) since 2022. He is also is a founding research faculty member of the Hessian Center for Artificial Intelligence. Jan Peters has received the Dick Volz Best 2007 US PhD Thesis Runner-Up Award, the Robotics: Science & Systems - Early Career Spotlight, the INNS Young Investigator Award, and the IEEE Robotics & Automation Society's Early Career Award as well as numerous best paper awards. In 2015, he received an ERC Starting Grant and in 2019, he was appointed IEEE Fellow, in 2020 ELLIS fellow and in 2021 AAIA fellow.

Despite being a faculty member at TU Darmstadt only since 2011, Jan Peters has already nurtured a series of outstanding young researchers into successful careers. These include new faculty members at leading universities in the USA, Japan, Germany, Finland and Holland, postdoctoral scholars at top computer science departments (including MIT, CMU, and Berkeley) and young leaders at top AI companies (including Amazon, Boston Dynamics, Google and Facebook/Meta).

Jan Peters has studied Computer Science, Electrical, Mechanical and Control Engineering at TU Munich and FernUni Hagen in Germany, at the National University of Singapore (NUS) and the University of Southern California (USC). He has received four Master's degrees in these disciplines as well as a Computer Science PhD from USC. Jan Peters has performed research in Germany at DLR, TU Munich and the Max Planck Institute for Biological Cybernetics (in addition to the institutions above), in Japan at the Advanced Telecommunication Research Center (ATR), at USC and at both NUS and Siemens Advanced Engineering in Singapore. He has led research groups on Machine Learning for Robotics at the Max Planck Institutes for Biological Cybernetics (2007-2010) and Intelligent Systems (2010-2021).

Domenico Prattichizzo

Wearable Haptics: From Robotics to Potential Cancer Treatments

Wearable haptics is a field that employs advanced, highly wearable robots to interact with the human sensorimotor system by applying forces to the body. This technology has been successfully utilized in virtual reality, robotic teleoperation, and, more recently, in the emerging field of human augmentation. In this talk, I will summarize the main results of wearable haptics and introduce a groundbreaking idea that leverages its application to mechanobiology to reduce the proliferation rate of cancer cells. Initial results from animal models are promising, and I am excited to share them with our community. If successful, this approach could offer a novel method for combating cancer.

Biography

Domenico Prattichizzo. IEEE Fellow. Professor of Haptics and Robotics at University of Siena; Senior Scientist of the IIT in Genova; Co-founder of two startups: WEART (weart.it) and EXISTO (existo.tech) on wearable haptics and wearable robotics; IEEE Fellow; Editor in Chief of IEEE Transactions on Haptics; President of EuroHaptics Society. Vice-Rector for Technology Transfer at University of Siena. Co-founder of the Italian Institute of Robotics and Intelligent Machine. Human and robotic hands, along with haptic perception and the art of manipulating objects, have polarized his research, which is increasingly oriented towards highly wearable haptics for virtual and augmented reality. He recently became interested in applications of mechanobiology and robotics. Scientific Coordinator of several research projects funded by the European Union, US and Japan. In 2013 he pioneered the field of haptics with seminal contributions on wearability in haptics. In 2015 he pioneered the field of human augmentation with contributions on the robotic sixth finger for stroke rehabilitation. He is the author of more than 900 publications in scientific journals, books, and conference proceedings. He is the inventor of more than 15 patents in the field of haptics, robotics, and wearables. He is co-author with Irfan Hussain and Simone Rossi of two books, respectively: Augmenting Human Manipulation Abilities With Supernumerary Robotic Limbs by Springer and Il Corpo Artificiale. Neuroscienze e Robot da Indossare by Raffaello Cortina Editore.

Marc Raibert

We've come a long way, and still have a way to go

1974, 1984, 1994, 2004, 2014, 2024

Biography

Marc Raibert is the Executive Director of The AI Institute and Founder of Boston Dynamics. He is a life-long roboticist, starting his robotics career over 45 years ago as a graduate student at MIT, where he wrote software that learned the dynamics of a robot manipulator. He spent 18 years as an academic researcher and tenured faculty at CalTech/JPL, Carnegie Mellon University, and MIT. He founded the Leg Laboratory, a lab that helped establish the scientific basis for highly dynamic robots and that set the stage for ground-breaking work on dynamic robots. He spent 30 years leading Boston Dynamics, arguably the most influential pure-play robotics research organization in the world, having produced robots such as BigDog, Atlas and Stretch, and that now delivers Spot robots to users around the world. Currently, Raibert is the Executive Director of The AI Institute, a new research lab focused on the most important problems in robotics and AI.

Raibert is highly visible in the robotics community, having given numerous keynote lectures and interviews, including TED, 60 Minutes, Turing Institute, WebSummit, Wired 25, MARS, REMARS, and many others. Raibert is a Founding Fellow of the Association for the Advancement of Artificial Intelligence, was inducted into the National Academy of Engineering in 2008, was named a Pioneer in Robotics by IEEE in 2022, and received the Engelberger Award in 2022. Recently he was included in Time Magazine’s 100 Most Influential People in AI. Two of Raibert’s robots were inducted into the Robot Hall of Fame in 2008 and 2012.

Karinne Ramirez-Amaro

Learning the How and Why from Experience: Combining Interpretable and Explainable Methods in Robot Decision-Making

Autonomous robots should efficiently and reliably learn new skills while reusing experiences. What is limiting the advancement of robotic autonomy? Autonomy has rapidly increased with the development of Interpretable and Explainable methods. Interpretable methods focus on understanding how the learned model reaches decisions by examining its structure and relationships. Explainable methods reveal why a model made specific decisions without requiring an understanding of the model itself. Combining these methods in robotic systems enhances the transparency of decision-making processes. While challenging, Interpretable and Explainable capabilities are crucial for deploying Robots in real and dynamic environments. In this talk, I will first introduce our interpretable AI methods that generate compact and general semantic models to infer human activities, enabling robots to gain a high-level understanding of human movements. Next, I will present our causal-based approach, which empowers robots to rapidly predict and prevent both immediate and future failures. This method helps robots understand why failures occurred, allowing them to learn from their mistakes, thus improving their future performances. Finally, I will discuss strategies for combining these methods into a single framework by integrating symbolic planning with hierarchical Reinforcement Learning. This integration allows us to learn flexible and reusable robot policies for manipulation tasks, creating holistic sequences of actions that can be executed independently. Interpretable and Explainable AI are key to developing general-purpose robots. These approaches enable robots to make complex decisions in dynamic and unpredictable environments by learning "how" and "why", ultimately improving robotic autonomy.

Biography

Karinne Ramirez-Amaro is an Associate Professor in the Electrical Engineering Department at Chalmers University of Technology, Sweden. She completed her Ph.D. (summa cum laude) at the Department of Electrical and Computer Engineering at the Technical University of Munich in 2015. She has received several awards, including the Price of an Excellent Doctoral degree for female engineering students and the Google Anita Borg Award. Her research interests include Interpretable and Explainable AI, Semantic Representations, Cause-based Learning Methods, Collaborative Robotics, and Human Activity Recognition and Understanding. She is one of the team leaders of the new Interpretable AI research theme at Chalmers. She has been an Associate Editor of various journals, such as IEEE Robotics and Automation Letters (RA-L) and ELSEVIER Robotics and Autonomous Systems (RAS). In 2022, Karinne was elected as a member of the Administrative Committee (AdCom) from the IEEE Robotics and Automation Society (RAS), and she was the chair of the IEEE RAS Women in Engineering (WiE) Committee. In 2023, she became an Associate Vice-President of Diversity, Equity and Inclusion for the RAS Member Activity Board.

Ludovic Righetti

Is locomotion a solved algorithmic problem?

Last ICRA, I suddenly realized that it was now “normal” to see quadrupeds or bipeds casually walk across the conference without any safety harness or close-by worried operators. A decade ago, this seemed quite out of reach. My next thought was that perhaps I needed to quickly find a new research topic… Was legged locomotion a solved algorithmic problem? In this talk, we will reflect on the rapid progress that enabled robots to walk, and sometimes run, out of the lab. We will argue that model-predictive control and, more recently, reinforcement learning algorithms have unlocked unprecedented capabilities. Yet, we will see that difficult challenges remain to make such robots fully autonomous and hopefully, one day, useful.

Biography

Ludovic Righetti is an associate professor jointly appointed in the electrical and computer engineering and in the mechanical and aerospace engineering departments at New York University. He holds an engineering diploma in computer science and a doctorate in science from the Ecole Polytechnique Fédérale de Lausanne and was previously a postdoctoral fellow at the University of Southern California and a group leader at the Max-Planck Institute for Intelligent Systems. His research focuses on the planning, control and learning of movements for autonomous robots, with a special emphasis on legged locomotion and manipulation. He is also interested in the broader societal impacts of robotics and AI and regularly works with international organizations on these topics, especially on issues related to peace and security. His work has received several awards including the 2010 Georges Giralt PhD Award, the 2011 IROS Best Paper Award, the 2016 IEEE RAS Early Career Award and the 2016 Heinz Maier-Leibnitz Prize from the German Research Foundation.

Nicholas Roy

Hierarchy, Abstractions and Geometry

In the last few years, the ability for robots to understand and operate in the world around them has advanced considerably. Examples include the growing number of self-driving car systems, the considerable work in robot mapping, and the growing interest in home and service robots. However, one limitation is that robots most often reason and plan using very geometric models of the world, such as point features, dense occupancy grids and action cost maps. To be able to plan and reason over long length and timescales, as well as planning more complex missions, robots need to be able to reason about abstract concepts such as landmarks, segmented objects and tasks (among other representations). I will talk about recent work in joint reasoning about semantic representations and physical representations and what these joint representations mean for planning and decision making.

Biography

Nicholas Roy is the Bisplinghoff Professor of Aeronautics & Astronautics and a member of the Computer Science and Artificial Intelligence Laboratory (CSAIL) at the Massachusetts Institute of Technology. He received his B.Sc. in Physics and Cognitive Science and his M.Sc. in Computer Science from McGill University. He received his Ph. D. in Robotics from Carnegie Mellon University. He has made research contributions to planning under uncertainty, machine learning, human-computer interaction and aerial robotics. He founded Project Wing at [x], and is the Autonomy Architecture Lead and a principal software engineer at Zoox.

Daniela Rus

Physical Intelligence

Physical intelligence in when AI's power to understand text, images and other online data can be used to make robots smarter. Physical intelligence demands compact models that understand the physical world, can run on the body of the robot, without the need for server farms, and can operate precisely and error-free. In this talk I will discuss liquid networks and their suitability for physical intelligence.

Biography

Daniela Rus is the Andrew (1956) and Erna Viterbi Professor of Electrical Engineering and Computer Science, Director of the Computer Science and Artificial Intelligence Laboratory (CSAIL) at MIT. Prof. Rus's research interests are in robotics and artificial intelligence. The key focus of her research is to develop the science and engineering of autonomy and intelligence. Prof. Rus is a MacArthur Fellow, a fellow of ACM, IEEE, AAAI and AAAS, a member of the National Academy of Engineering, National Academy of Sciences, and of the American Academy of Arts and Sciences. She is the recipient of the Engelberger Award for robotics, the IEEE RAS Pioneer award, IEEE Robotics and Automation technical award, Mass TLC Innovation Catalyst Award, and the IJCAI John McCarthy Award. She earned her PhD in Computer Science from Cornell University. Prof. Rus aspires to help build a world where robotics and AI systems help with people with physical and cognitive work, accelerate scientific discovery, and enable solutions to the grand challenges facing humanity. She is the co-author of the books The Heart and The Chip (March 2024) and The Mind's Mirror (August 2024).

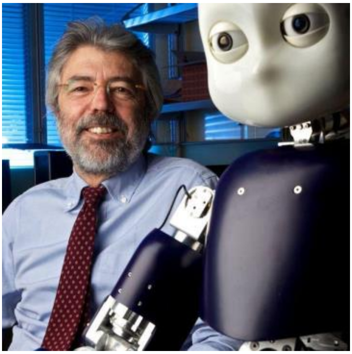
Giulio Sandini

From Active Vision to iCub and the Elusive Quest for Cognition

The use of artificial systems to develop and test theories of human perception began with the "Active Perception" paradigm (Bajcsy, 1988; Aloimonos, 1988; Ballard, 1989). About 40 years ago, this paradigm shifted the idea of perception from a passive, "observational" process to one involving self-generated, purposeful actions. This intuition, independently paralleled by neuroscientists, played a key role in the emergence of "Computational Neuroscience" and led to the use of robots to study human intelligence. Initially, robot heads were used to explore sensorimotor coordination, gaze control and visual attention, eventually progressing to full humanoids to investigate human cognitive abilities. In this talk, I will discuss how, despite significant advancements in the last 40 years, the current implementations are far from the adaptable, versatile machines endowed with the abilities to reason and act in the physical world needed to assist humans in daily life. I will argue for a more convergent approach based on a shared cognitive architecture (the machinery of the human mind) and emphasize the importance of understanding the origins and timeline of human adaptive abilities, highlighting the complementary roles of evolutionary, epigenetic, developmental, and learning processes.

Reasoning and discussing the "big picture" offers the possibility to share views and results at a level of abstraction where engineers, neuroscientists, psychologists, social scientists and philosophers among others can equally contribute without being diverted by implementation or experimental details which can be dealt with and appreciated within the respective specialized communities. They "simply" need to form and extended community understanding and supporting each other at a fundamental "meta-level".

Biography



Giulio Sandini is a Founding Director of the Italian Institute of Technology where in 2006 he established the department of Robotics, Brain and Cognitive Sciences. As a research fellow and Assistant Professor at the Scuola Normale in Pisa and Visiting Researcher at the Neurology Department of the Harvard Medical School he investigated visual perception and sensorimotor coordination in humans and technologies for Brain Activity Mapping in children with learning disabilities. As a professor of bioengineering at the University of Genova in 1990 he founded the LIRA-Lab (Laboratory for Integrated Advanced Robotics) which was to become the birthplace of the iCub humanoid robot. In 1996 he was Visiting Scientist at the Artificial Intelligence Lab of MIT. Giulio Sandini research activity is characterized by an engineering approach to the study of natural intelligent systems with a focus on the design and implementation of artificial systems to investigate the development of human perceptual, motor and cognitive abilities (and vice-versa).

Davide Scaramuzza

Agile Robotics: from Cameras to Neuromorphic Sensors

Robots play a crucial role in inspection, agriculture, logistics, automated driving, and search-and-rescue missions. Yet, they lag behind humans in speed, versatility, and robustness. I will show how combining model-based and machine-learning methods with the power of new, low-latency sensors, such as event cameras, can allow autonomous systems such as drones, legged robots, robot arms, and cars to achieve unprecedented agility and robustness. This can result in better productivity and safety of future autonomous systems.

Biography

Davide Scaramuzza is a Professor of Robotics and Perception at the University of Zurich. He did his Ph.D. at ETH Zurich, a postdoc at the University of Pennsylvania, and was a visiting professor at Stanford University. His research focuses on autonomous, agile navigation of micro aerial vehicles using standard and event-based cameras. He pioneered autonomous, vision-based navigation of drones, which inspired the navigation algorithm of the NASA Mars helicopter and many drone companies. In 2022, his team demonstrated that an AI-powered drone could outperform the world champion of drone racing, a result published in Nature. He has been consulting the United Nations on disaster response, the Fukushima Action Plan, disarmament, and AI for good. For his research contributions, he has won many awards, including the very recent IEEE Technical Field Award, which he received at the latest ICRA 2024 conference in Japan, the IEEE Robotics and Automation Society Early Career Award, a European Research Council Consolidator Grant, and many paper awards, including the IROS 2023 Best Paper Award, the IEEE Robotics and Automation Letters' and the IEEE Transactions on Robotics best paper awards. Davide contributed significantly to visual-inertial state estimation, vision-based agile navigation of micro aerial vehicles, and low-latency, robust perception with event cameras. His results have been transferred to many products, from drones to automobiles, cameras, AR/VR headsets, and mobile devices. Davide counts several entrepreneurial achievements: in 2015, he co-founded Zurich-Eye, which became Meta Zurich, which developed the world-leading virtual-reality headset Meta Quest (25 million devices sold). In 2020, he co-founded SUIND, which builds autonomous drones for precision agriculture. Many aspects of his research have been featured in the media, such as The New York Times, The Economist, and Forbes.

Brian Scassellati

Robots that Support Human Cognitive and Social Skills

People routinely seek out personalized, one-on-one support when they are trying to learn new skills, to change their behavior, and to seek out guidance – from teachers, coaches, and mentors. The past decade has seen social robots take on many of these roles, but also with a level of privacy and security that may not be possible in human-human interactions. In this talk, I'll show some of the most promising areas in education and therapy where robots have been effectively deployed (including for social skill development for children and adults with autism), trace some of the cognitive science of why these interventions are effective (including results on compliance and learning rates as a result of embodiment), and give a quick introduction to some of the unique ethical issues that arise when using robots in this way.

Biography

Brian Scassellati is the A. Bartlett Giamatti Professor of Computer Science, Cognitive Science, and Mechanical Engineering at Yale University. His research focuses on human-robot interaction, cognitive modeling, and social behavior. He is particularly interested in how robots can be used to understand human social behavior and on building artefacts that support cognitive and social skills in people with unique needs. He was named a Fellow of the Association for the Advancement of Artificial Intelligence (AAAI) in 2024, a Leshner Leadership Fellow for Public Engagement with Science by AAAS in 2020, recipient of the Dylan Hixon '88 Prize for Teaching in the Natural Sciences in 2020, and an Alfred P. Sloan Research Fellow in 2007. His research has been recognized with 10 Best Paper awards, was twice named as a "Top 100 Innovation of the Year" by Time Magazine, and a "Top 10 Innovation to Watch" by the Society of Manufacturing Engineers.

Bruno Siciliano

A Revolutionary Theranostics Approach for Robotized Colonoscopy

This talk will present the underlying concepts of EndoTheranostics, a novel ERC Synergy Grant project aiming at revolutionizing the diagnosis and therapy (theranostics) of colorectal cancer (CRC), impacting the quality of life of millions of individuals. CRC represents a significant proportion of malignant diseases. Interventions are often carried out during the latter stages of development, leading to low patient survival rates and poor quality of life. In 2022 a European Commission report stated that "colonoscopy-based screening has higher sensitivity than testing for blood in stool, but it is less acceptable to participants". At the same time, effective methods to treat polyps in the colon are limited. Current approaches are often associated with unsafe oncological margins and high complication rates, requiring life-changing surgery. EndoTheranostics will usher in a new era for screening colonoscopy, advancing the frontiers of medical imaging and robotics. A tip-growing or eversion robot with a sleeve-like structure will be created to extend deep into hollow spaces while perceiving the environment through multimodal imaging and sensing. It will also act as a conduit to transfer miniaturized instruments to the remote site within the colon for theranostics. With these capabilities, the system will be able to offer: (i) painless colon cleansing in preparation for endoscopy, (ii) real-time polyp detection and tissue characterization through AI-assisted multimodal imaging, (iii) effective removal of polyps by conveying a "miniature mobile operating chamber" equipped with microsurgical tools to the target through the lumen of the eversion robot.

Biography

Bruno Siciliano is professor of robotics and control at the University of Naples Federico II. He is also Honorary Professor at the University of Óbuda where he holds the Kálmán Chair. His research interests include manipulation and control, human–robot cooperation, and service robotics. Fellow of the scientific societies IEEE, ASME, IFAC, AAIA, he received numerous international prizes and awards, including the recent 2024 IEEE Robotics and Automation Pioneer Award. He was President of the IEEE Robotics and Automation Society from 2008 to 2009. He has delivered more than 150 keynotes and has published more than 300 papers and 7 books. His book "Robotics" is among the most adopted academic texts worldwide, while his edited volume "Springer Handbook of Robotics" received the highest recognition for scientific publishing: the 2008 PROSE Award for Excellence in Physical Sciences & Mathematics. His team has received more than 25 million Euro funding in the last 15 years from competitive European research projects, including two ERC grants.

Roland Siegwart

Flying Robots – From basic flight capabilities to autonomous navigation and in-flight physical interactions

In the last 20 years, flying robots have evolved from fascinating lab prototypes to extremely useful tools for aerial imaging, search and rescue, and inspections at height. However, the limited flight time and payload, as well as the restricted computing power of drones renders autonomous operations quite challenging. This talk will focus on the design and autonomous navigation of flying robots. Innovative designs of flying systems, from solar airplanes for continuous flights to hybrid concepts combining vertical take-off and landing with the efficiency of fixed-wing flight, and mainly omni-directional and interactive multi-copters are presented. These omni-directional flying robots enable physical work at height, thus opening totally new challenges and applications.

Biography

Roland Siegwart (born in 1959) is professor for autonomous mobile robots at ETH Zurich, founding co-director of the Wyss Zurich accelerator and member of the board of directors of multiple high-tech companies. He studied mechanical engineering at ETH, spent ten years as professor at EPFL Lausanne (1996 – 2006), was vice president of ETH Zurich (2010 - 2014) and held visiting positions at Stanford University and NASA Ames.

He is and was the coordinator of multiple European projects and co-founder over half a dozen spin-off companies, including Wingta, Anybotics, Sevensense, Voliro and Tethys. He is an IEEE Fellow, recipient of the IEEE RAS Inaba Technical Award, the IEEE RAS Pioneer award and officer of the International Federation of Robotics Research (IFRR). He is on the editorial board of multiple journals in robotics and was a general chair of several conferences in robotics including IROS 2002, AIM 2007, FSR 2007, ISRR 2009, FSR 2017 and CoRL 2018. His interests are in the design and navigation of flying, wheeled, walking and swimming robots operating in complex and highly dynamical environments. Since over 20 years, his lab is pioneering the field of flying robots.

Jean-Jacques Slotine

Stable Adaptation and Learning

While we may soon have AI-based artists or scientists, we are nowhere near autonomous robot plumbers. The human brain still largely outperforms robotic algorithms in most tasks, using computational elements 7 orders of magnitude slower than their artificial counterparts. Similarly, current large scale machine learning algorithms require millions of examples and close proximity to power plants, compared to the brain's few examples and 20W consumption. In robotics, the relative sparsity of data and the prevalence of distribution shifts lead to fragile reliance on simulations or elaborate data pooling efforts, and move stable online sim-to-real centerstage, e.g., in contact-rich contexts where friction and uncertainty on mass properties and geometry are key elements. We study how modern nonlinear systems tools, such as contraction analysis, virtual dynamical systems, and adaptive nonlinear control can yield quantifiable insights about learning, generalization, and fast adaptation in large physical systems. For instance, we show how stable implicit sparse regularization can be exploited in adaptive prediction or control to continually select online relevant dynamic models out of plausible physically-based candidates, and how most fundamental results on gradient descent and optimization based on convexity can be replaced by much more general ones based on Riemannian contraction.

Time permitting, we will discuss a new approach to dense associative memories and transformers directly inspired by astrocyte biology. This may be the first contribution to AI of neuroscience results from the last 50 years.

Biography

Jean-Jacques Slotine is Professor of Mechanical Engineering and Information Sciences, Professor of Brain and Cognitive Sciences, and Director of the Nonlinear Systems Laboratory at MIT. He received his Ph.D. from the Massachusetts Institute of Technology in 1983. After working at Bell Labs in the computer research department, he joined the faculty at MIT in 1984. He has held Invited Professor positions at College de France, Ecole Polytechnique, Ecole Normale Superieure, Università di Roma La Sapienza, and ETH Zurich. Research in Professor Slotine's laboratory focuses on developing rigorous but practical tools for nonlinear systems analysis and control. These have included key advances and experimental demonstrations in the contexts of sliding control, adaptive nonlinear control, adaptive robotics, machine learning, and contraction analysis of nonlinear dynamical systems. One of the most cited researchers in systems science, he was a member of the French National Science Council from 1997 to 2002, a member of Singapore's A*STAR SigN Advisory Board from 2007 to 2010, a Distinguished Faculty at Google AI from 2019 to 2023, and has been a member of the Scientific Advisory Board of the Italian Institute of Technology since 2010.

Kenji Suzuki

Advancing Human Capabilities from Assistive Robotics to Wearable Cyborgs

Assistive and wearable robotics technology brings out latent human capabilities and potential abilities of people. This is a research domain about the robot-assisted human motor control that synthesizes musculoskeletal biomechanics and neural control. Key issue is to detect the user's motor intention in a contingent manner with proper consistencies, and continuously adapt the behavior that vary with time. This enables the technologies to be perceived as a natural extension of the body. In addition, the challenge to using soft robots is making their behavior precise and efficient enough to accomplish the given task in a reasonable amount of time. In this talk, several case studies related to advanced assistive robotics are introduced with examples of wearable robots through the design, implementation and clinical challenge. An exoskeletal robot and personal mobility vehicle are developed for supporting and assisting people with disabilities in their lower limbs, face, neck, arms or hands, such as elderly individuals and/or people with disabilities, including a study on voluntary initiation of movement. All wearable robots that understand human intentions will evolve into cyborg technology. Recent studies toward wearable cyborg technology for the future are also discussed.

Biography

Kenji Suzuki is currently a full professor, and also an executive officer and dean of the Institute of Systems and Information Engineering, University of Tsukuba. He is also a vice-chair at the Center for Innovative Medicine and Engineering, University of Tsukuba Hospital. He received the Dr. Eng. in Pure and Applied Physics from Waseda University, Tokyo, Japan, in 2003. His primary research interests include artificial intelligence, Cybernics, wearable robotics and devices, affective computing, social robotics and assistive robotics with a particular emphasis on machine learning, pattern classification and dynamical modeling approaches. A special emphasis is laid on the design of empowering people, particularly for elderly, adults and children with special needs. He currently serves as an elected administrative committee member of the IEEE Robotics and Automation Society.

Satoshi Tadokoro

Rescue Robotics Challenge for 2050

Many research activities into robotics for search and rescue (SaR) began in the 1990s, spurred by major disaster events, such as the Hanshin-Awaji Earthquake in Japan and the Oklahoma City Bombing in the US, both in 1995. This talk will highlight some early efforts in the field of humanitarian research. RoboCup Rescue initiated international competitions in 1999, aiming to develop robotic solutions for emergency response. While the ultimate vision of "mighty rescue robots" as envisioned in the RoboCup finals in 2050 remains elusive, some predictions have already come to fruition. By 2020, robots have actively contributed to real disaster events, such as the East Japan Earthquake. The IEEE RAS Technical Committee on Safety, Security and Rescue Robotics, established in 2001, and the International Rescue System Institute (IRS), established in 2002, have played key roles for advancing the technology, promoting collaboration among researchers, and applying prototypes to real-world problems. The Japanese government spearheaded several notable projects, including the MEXT DDT Project on rescue robotics (2002-2007) and a NEDO Project (2006-2011), which played crucial roles in responding to the Fukushima-Daiichi Nuclear Power Station accident in 2011 by Quince. The Japan Cabinet Office's ImPACT Tough Robotics Challenge (2014-2019) further advanced the field, resulting in Innovations such as the Active Scope Camera, a serpentine robot with visual, auditory, and haptic sensors, and the Cyber Rescue Canine, a digitally enhanced rescue dog. We will explore how robotics can further mitigate disaster damages in the future and discuss the ongoing advancements and challenges in the field.

Biography

Satoshi Tadokoro is a Professor of Graduate School of Information Sciences and International Research Institute of Disaster Science as well as the Director of Tough Cyberphysical AI Research Center (TCPAI), Tohoku University. He graduated from the University of Tokyo in 1984. He was an associate professor in Kobe University in 1993-2005, and joined Tohoku University as a full professor in 2005. He was a Vice/Deputy Dean of Graduate School of Information Sciences in 2012-14, and is the Director of TCPAI since 2019 in Tohoku University. He has been the President of International Rescue System Institute (IRS) since 2002, and was the President of IEEE Robotics and Automation Society (RAS) in 2016-17. He received awards including IEEE RAS George Saridis Leadership Award in Robotics and Automation, and Commendation for S&T by the Minister of MEXT. He served as the Program Manager of MEXT DDT Project on rescue robotics in 2002-07, and was the Program Manager of Japan Cabinet Office ImPACT Tough Robotics Challenge Project on disaster robotics in 2014-19 having 62 international PIs and 300 researchers that created Cyber Rescue Canine, Dragon Firefighter, etc. His research team in Tohoku University has developed various rescue robots, two of which called Quince and Active Scope Camera are widely recognized for their contribution to disaster response including missions in the Fukushima-Daiichi Nuclear Power Station Nuclear Reactor Buildings. He is an IEEE Fellow, RSJ Fellow, JSME Fellow, and SICE Fellow.

Atsuo Takanishi

Bipedal Walking Robot Developments in The Early Days, 1960s to 1980s, in Japan

My talk will be on what happened in the developments of bipedal walking robots in the early days, from 1960s to 1980s, in Japan. The scientific research on bipedal walking robots initiated by Ichiro Katoand his pupils in his laboratory at Waseda University in the 1960s is for the first time in the history of robotics. His team developed a hydraulically powered one leg mechanism named WL-1 in 1966 to understand human leg motion while walking. Then they started to build two diverse types of bipedal walking robots; one is hydraulically powered robot WL-3 that realized static leg swing, sitting, understanding motion, and the other is pneumatic one WAP-1 that realized static walking, both in 1969.Then, he and three professors at the university collaborated to develop a humanoid robot WABOT-1 in 1970, then the robot—the first full-scale anthropomorphic robot in the world—completed in 1973.Its leg part is WL-5 being able to static bipedal walk for the mobility of WABOT-1. After those historical achievements, the numbers of research groups all from universities gradually increased, mostly aiming to implement dynamic walking such as BIPER series, CW series, Kenkyaku, Idaten, MEG-2 as well as WLseries, developed from the 1970s to 1980s. I will introduce those robots with the specifications such as the number of freedoms/configurations, dimensions, weights, actuator types, sensing systems, main materials, scientific/engineering achievements, controller CPUs, etc.

Biography

Atsuo Takanishi is Professor of the Department of Modern Mechanical Engineering as well as the director of the Humanoid Robotics Institute, Waseda University. He received the B.S.E. degree in 1980, the M.S.E. degree in 1982 and the Ph.D. degree in 1988, all in Mechanical Engineering from Waseda University. His current researches are related to Humanoid Robotics and its applications in medicine and well-being, such as the biped walking/running humanoids, the saxophonist humanoids, medical training system with humanoid patients, etc. He was the former President of the Robotics Society of Japan (RSJ) from2015 to 2016, and was the Chairman of the Japanese Council of the International Federation for the Promotion of Mechanism and Machine Science (Jc-IFToMM). He is a member of many robotics and medicine related academic societies and governmental committees such as IEEE, RSJ, and the Society of Mastication Systems, the Robot Revolution Initiatives, and a Vice President of the Fukuoka Prefectural Semiconductor & Digital Industries Development Council, and the chair of the Workroid Users Association. etc. He is a fellow of IEEE, RSJ and the Japanese Society of Mechanical Engineers (JSME). He received the RSJ Best Journal Paper Award (1998), RSJ/JSME ROBOMECH Award (1998), BusinessWeek Best of Asia Award (2001), IROS2003 Best Paper Award – Application (2004), JSME Best Journal Paper Award (2006), ROBIO2007 Best Conference Paper Award (2007), RSJ Advanced Robotics Best Paper Award (2015) and many more domestic and international awards.

Carme Torras

Robotics in healthcare – Closing the reality gap through co-design and technoethics education

Co-designing robotic assistants with all stakeholders in a healthcare context helps to reveal research topics that boost their usability in the real-world. Two robot prototypes developed in this way will be showcased, which have led to focus research on various forms of personalization, fluent human-robot interaction, easy teaching, and continuous adaptation. The first prototype is a small robot arm for feeding people, developed with the managing team, physicians, nurses, innovation technicians and sixty voluntary patients in the Sociosanitary Park Pere Virgili in Barcelona. The second prototype has been designed with a neurologist, a therapist and a social worker to provide cognitive training to patients in the ACE Alzheimer Centre in Barcelona. The two experiences have also revealed the importance of taking into account the ethical perspectives of all the involved participants, from researchers to healthcare personnel and patients. An initiative to foster debate on ethics of social robotics and AI among technology students, by exploiting the engaging appeal of science fiction, will be presented. While social robotics shares several ethics issues with AI, embodiment makes a huge difference in other aspects, some beneficial and some riskier.

Biography

Carme Torras is Research Professor at the Institut de Robòtica i Informàtica Industrial (CSIC-UPC) in Barcelona, where she heads a large research group on assistive robotics. She has supervised 22 PhD theses and led 17 European projects, among them her ERC Advanced Grant project CLOTHILDE – Cloth manipulation learning from demonstrations. She has regularly contributed to ICRA with 28 papers spanning the 37-year period from 1988 to 2024. Prof. Torras has extensively served the robotics community by participating in many advisory and evaluation committees, such as the review panels of the Swiss National Centre of Excellence in Robotics, Istituto Italiano di Tecnologia, German Research Foundation, and European Research Council. She has been Senior Editor of the IEEE Transactions on Robotics, and IEEE RAS Associate VP for Publications. Prof. Torras is IEEE, EurAI and ELLIS Fellow, member of Academia Europaea, the Royal Academy of Sciences and Arts of Barcelona, and the Royal Engineering Academy of Spain. Her research achievements have been recognized with several distinctions, among which the Catalan National Research Award (2020), and the Spanish National Research Prize in mathematics and ICT (2020), the highest research recognition in Spain. Committed to promoting ethics in the deployment of digital technologies, she has developed freely available online materials to teach a course on “Ethics in Social Robotics and AI” based on her science fiction novel The Vestigial Heart (MIT Press, 2018). She is vice-president of CSIC’s Ethics Committee.

Heike Vallery

Paradigm shifts and technological enablers in rehabilitation robotics

Over the past decades, rehabilitation robotics has undergone major transformations, both in therapeutic paradigms and technical tools. Initially, rigid robots guided users along predetermined trajectories in repetitive movements. However, clinical studies with such devices did not show the anticipated large improvements in therapeutic outcomes. These sobering findings in turn fueled new therapeutic approaches and technological innovations. Today, a diverse set of robotic devices facilitates interactive therapy and support across the continuum of care. In this talk, I will highlight key barriers that have been overcome over the years, and the robotics technologies that played pivotal roles in this process. Examples will include the development of compliant, intelligent, and lightweight technology that aims to enhance not just motor function, but quality of life, and how these systems enable users to explore and use their capacities more freely. I will conclude with a discussion on current trends and future directions in the field, including low-cost robotics and home therapy.

Biography

Heike Vallery graduated from RWTH Aachen University with a Dipl.-Ing. degree in Mechanical Engineering in 2004. Since then, she has been working on robot-assisted rehabilitation and prosthetic legs, in close collaboration with clinicians and partners from industry. In 2009, she earned her Dr.-Ing. from the Technische Universität München and then continued her academic career at ETH Zürich, Khalifa University and TU Delft. Today, she is a full professor at RWTH Aachen and TU Delft, and also holds an honorary professorship at Erasmus MC in Rotterdam. Heike Vallery received numerous fellowships and awards, such as the 1st prize of the euRobotics Technology Transfer Award 2014, and recently an Alexander-von-Humboldt professorship to join RWTH Aachen. Her main research interests are in design and control of minimalistic robotics.

Vincent Vanhoucke

Constitutional Embodied AI

Foundation models are a marked step change in common-sense reasoning, task planning, and perception capabilities. A key missing ingredient was for them to also understand physical interaction, a gap that the robotics community at large is filling rapidly. In this talk, I will discuss some of the intriguing consequences of having Vision-Language-Action models that can be tasked using natural language. In particular, I'll explore how the many levels of abstraction that language can naturally express can give rise to new ways to approach human-centered alignment of autonomous systems.

Biography

Vincent Vanhoucke is currently a Distinguished Engineer at Waymo. His research has spanned many areas of artificial intelligence and machine learning, from speech recognition to computer vision and robotics. At Google, he helped design and launch the first large scale production deep learning system which powered Google Voice Search, work that 10 years later earned the Best Paper Award from Signal Processing Magazine. In Google Brain, he worked on DistBelief, TensorFlow, GoogLeNet and the 'Inception' series of computer vision architectures, winning the 2014 ImageNet challenge. His Udacity lecture series has introduced over 100,000 students to Deep Learning. He founded the Robotics research team, now part of Google DeepMind, and grew it to 150 researchers and engineers. He won academic awards for notable works such as QT-Opt, SayCan, and RT-X and helped put Foundation Models for robotics on the map. He is President of the Robot Learning Foundation, which organizes the Conference on Robot Learning, now in its eighth year. He holds a doctorate from Stanford University and a diplôme d'ingénieur from the École Centrale Paris.

Manuela Veloso

Towards a Seamless Integration of Humans and Mobile Task Robots

Mobile robots are increasingly being integrated into various human environments to perform a wide range of navigation and service tasks. Such mobile task robots need to be in a continuous active interaction with humans, with other robots, and with the environment. In this talk, I will present a series of challenges and solutions resulting from our experience with mobile service robots in various environments with different levels of familiarity with robots. I will focus on multiple aspects, including planning, instruction, learning, safety, task performance, reconnaissance, environment monitoring, explainability, continuous presence, multirobot coordination, and the use of GenAI for communication and vision to enhance overall performance. I will conclude with some thoughts on how to proceed to better capture development and general acceptance for robots as AI agents in the physical world.

Biography

Manuela Veloso is the Head of JPMorganChase AI Research & Herbert A. Simon University Professor Emerita of Computer Science at Carnegie Mellon University, where she was faculty in the Computer Science Department and then Head of the Machine Learning Department. Veloso has a B.Sc. degree in Electrical Engineering and an M.Sc. in Electrical and Computer Engineering from Instituto Superior Técnico, Lisbon, an M.A. in Computer Science from Boston University, and a Ph.D. in Computer Science from Carnegie Mellon University. Veloso has Doctorate Honoris Causa degrees from the Örebro University, Sweden, the Instituto Universitário de Lisboa (ISCTE), Portugal, the Université de Bordeaux, France, and the Universidade Católica of Portugal. She served as president of AAAI, and she is co-founder and past president of RoboCup. She is a fellow of AAAI, IEEE, AAAS, and ACM. She is the recipient of the ACM/SIGART Autonomous Agents Research Award, the Einstein Chair of the Chinese Academy of Sciences, an NSF Career Award, and the Allen Newell Medal for Excellence in Research. Veloso is a member of the National Academy of Engineering. Her research interests are in core AI as agents with perception, cognition, and action, in particular autonomous robots, multirobot systems, continuously learning agents, and AI in finance. She aims at a future with humans and AI in a seamless, responsible, effective, sustainable, symbiotic interaction. Veloso has graduated 48 PhD students and co-authored more than 400 journal and conference papers.

Birgit Vogel-Heuser

Field-level automation architectures: A key challenge for adaptable, self-healing production systems

Many robotic applications require a robot to operate in an environment with unknowns or uncertainty, at least initially, before it gathers enough information about the environment. The robot must rely on sensing and perception to feel its way around. Moreover, perception and motion need to be coupled synergistically in real time, such that perception guides motion, while motion enables better perception. In this talk, I will discuss progress in combining perception and motion of a robot to achieve perception and manipulation tasks such as autonomous manipulation of model-free deformable linear objects, contact-rich, complex assembly, and semantic object search in unknown or uncertain environments, challenges ahead, and potential applications.

Biography

Birgit Vogel-Heuser is full Professor of Automation and Information Systems, Member of MIRMI and MDSI and the Vice Dean Research and Innovation of the School of Engineering Design at the Technical University Munich (TUM), Germany. Over ten years, she acquired industrial experience in the automation sector. Her research focuses on intelligent, evolvable field-level automation and appropriate architectures for manufacturing and logistics systems. She was speaker of the Collaborative Research Center CRC 768 Innovation Cycles and has been program committee member of the Priority Programs 1593 and 2422. Her work continuously focuses the interdisciplinary junction of mechanical, electrical and software engineering. She is IEEE fellow and serves as Automation Coordinator of in RAS TAB. She has held the Order of Merit of the Federal Republic of Germany since 2024.

Jing Xiao

Robotic Perception-Action Synergy in Unknown and Uncertain Environments

Many robotic applications require a robot to operate in an environment with unknowns or uncertainty, at least initially, before it gathers enough information about the environment. The robot must rely on sensing and perception to feel its way around. Moreover, perception and motion need to be coupled synergistically in real time, such that perception guides motion, while motion enables better perception. In this talk, I will discuss progress in combining perception and motion of a robot to achieve perception and manipulation tasks such as autonomous manipulation of model-free deformable linear objects, contact-rich, complex assembly, and semantic object search in unknown or uncertain environments, challenges ahead, and potential applications.

Biography

Jing Xiao is the Deans' Excellence Professor, William B. Smith Distinguished Fellow in Robotics Engineering, Professor and Head of the Robotics Engineering Department, Worcester Polytechnic Institute (WPI). She joined WPI as the Director of the Robotics Engineering Program in 2018 from the Department of Computer Science, University of North Carolina at Charlotte, where she received the College of Computing Outstanding Faculty Research Award in 2015. She led the Robotics Engineering Program to become the first full-fledged Robotics Engineering Department in the U.S. in July 2020. She is the Site Director of NSF Industry/University Cooperative Research Center on Robots and Sensors for Human Well-being (ROSE-HUB) at WPI. Her research spans robotics, haptics, multi-modal perception, and artificial intelligence, with two highly related themes: one is the focus on "contact sport", i.e., the contact and interaction between a robot or a part it holds and the environment, and the other is real-time adaptiveness of robots to uncertainty and uncertain changes in an environment based on perception and learning. Jing Xiao is an Editor of the IEEE Transactions on Robotics. She is a recipient of the 2022 IEEE Robotics and Automation Society George Saridis Leadership Award in Robotics and Automation.

Eiichi Yoshida

Unified Data-Driven Anthropomorphic Contact-Rich Motion Synthesis

Motions involving contacts are still challenging even for the most advanced robots like humanoids witnessing remarkable progress recently while we humans make them naturally in our daily lives. We address research questions on this challenge by unifying well-established model-based methodologies and versatile data-driven approaches based on machine learning leveraging common latent space representation. Contact motions are expressed as a network with encoded "contact symbols" and then synthesized into whole-body contact-rich motions based on a control strategy acquired through learning and inverse optimal control.

Biography

Eiichi Yoshida is Professor of Tokyo University of Science (TUS), at the Department of Medical and Robotic Engineering Design, Faculty of Advanced Engineering since 2022. He received M.E and Ph. D degrees in Precision Machinery Engineering from Graduate School of Engineering, the University of Tokyo in 1996. He then joined the former Mechanical Engineering Laboratory, later in 2001 reorganized as National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan. He served as Co-Director of AIST-CNRS JRL (Joint Robotics Laboratory) at LAAS-CNRS, Toulouse, France, from 2004 to 2008, and at AIST, Tsukuba, Japan from 2009 to 2021. He was also Deputy Director of Industrial Cyber-Physical Systems Research Center, and TICO-AIST Cooperative Research Laboratory for Advanced Logistics in AIST from 2020 to 2021 before joining TUS. He is an IEEE Fellow, and member of RSJ, SICE and JSME. He received several awards including Best Paper Award in Advanced Robotics Journal, and the honor of Chevalier l'Ordre National du Mérite from the French Government. His research interests include robot task and motion planning, human modeling, humanoid robotics and advanced logistics technology.

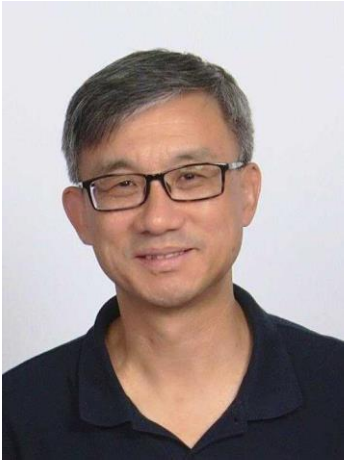
Michael Yu Wang

Robot Manipulation Skill Learning and Engineering

With the advent of the large language models (LLMs), “end-to-end” large robot action models begin to blossom in very recent years with enormous enthusiasm for making humanoids and other robots intelligent. Initial results of recent advances seem promising, and major collaborative efforts are underway to collect demonstration data. For industrial automation applications, such as electronics assembly, the challenge is to enable robots with essential assembly skills in addition to the intelligence needed to deal with varying environmental conditions and dynamic obstacles on a factory floor. For robot skill acquisition, I argue that we need systematic approaches to integrate engineering modularity with learning, rather than a monolithic framework with the extensive and time-intensive online learning processes.

Humans can effortlessly complete complex assembly tasks, relying on their acute visual and tactile sensing and skill learning abilities. Naturally, it is essential to endow robots with similar visual and tactile perception abilities as humans. This multi-modal perception necessitates robots to learn basic assembly skills and generalize these skills to other relevant situations to achieve comparable results. I’ll present a robot system for insertion tasks in unstructured environments, which integrates learning-based trajectory planning, passive interaction control, and a vision-based tactile sensor-guided alignment algorithm. The system permits a data-efficient training pipeline adept at learning from a limited set of demonstrations to generate human-like insertion trajectories, affirming the robustness and reliability of our approach.

Biography



Michael Yu Wang is a Chair Professor and the Founding Dean of the School of Engineering of the Great Bay University, China. He has served on the engineering faculty at University of Maryland, Chinese University of Hong Kong, National University of Singapore, Hong Kong University of Science and Technology, and Monash University. He has numerous professional honors – Kayamori Best Paper Award of 2001 IEEE International Conference on Robotics and Automation, the Compliant Mechanisms Award-Theory of ASME 31st Mechanisms and Robotics Conference in 2007, Research Excellence Award (2008) of CUHK, and ASME Design Automation Award (2013). He was the Editor-in-Chief of IEEE Trans. on Automation Science and Engineering, and served as an Associate Editor of IEEE Trans. on Robotics and Automation and ASME Journal of Manufacturing Science and Engineering. He is a Fellow of ASME, HKIE and IEEE. He received his Ph.D. degree from Carnegie Mellon University.