RSE events

Franco–Scottish Seminar: Robotics

Wednesday 15 November 2017

9 am–5 pm

This Seminar is organised in partnership with the French Embassy, London

The Royal Society of Edinburgh (RSE) and the French Embassy in London are collaborating on a programme of science events designed to explore and publicly present areas of science in which both Scotland and France have a powerful presence. This year's Seminar is on the topic of Robotics

The Seminar is aimed at academics and practitioners working in the area of Robotics

The Seminar is free to attend

The Seminar will be followed by an evening Public Lecture (6 pm–7.30 pm), delivered by **Professor Sethu Vijayakumar FRSE,** entitled, *Shared Autonomy: The Future of Interactive Robotics*
Seminar participants must register for the lecture separately

For further information and to book, visit:
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Wednesday 15 November

09.00 **Registration opens**

09.30 **Welcome**
Royal Society of Edinburgh
Professor Sethu Vijayakumar FRSE, Professor of Robotics, University of Edinburgh, UK. Director, Edinburgh Centre for Robotics and Royal Academy of Engineering–Microsoft Research Chair in Robotics

French Embassy
Mrs Stephanie Dos Santos, Deputy Scientific Attachée: Information and Communication Technology

09.45 **Robotic Tactile Sensing and e-skin Technologies**
Dr Ravinder Dahiya, Professor of Electronics and Nanoengineering, University of Glasgow

10.15 **Endoscopic Surgery through Natural Orifices : a Perfect Case for Robotics in the Surgical Field**
Professor Michel de Mathelin, Strasbourg University

10.45 **Q and A**

11.00 **Coffee/tea break**

11.30 **Establishing Trust in Autonomy Through Explainable AI**
Professor Helen Hastie, Professor of Computer Science, Heriot-Watt University

12.00 **Tactile Perception In and Outside our Body**
Professor Vincent Hayward, Professor (on leave), Université Pierre et Marie Curie (UPMC), Paris

12.30 **Q and A**

12.45 **Lunch**

14.00 **Reaching the Unreachable: The Science of Robot Locomotion**
Dr Zhibin Li, Lecturer, University of Edinburgh

14.30 **Robotics: the Can Do and Can't Do**
Dr Jean-Pierre Merlet, Senior Research Scientist, INRIA

15.00 **Q and A**

15.15 **Coffee/tea break**

15.45 **Bipedal Walking: A Multidisciplinary Perspective**
Professor Jean-Paul Laumond, Directeur de Recherche, LAAS-CNRS

16.15 **Closing Discussion and Q and A**

16.45 **Closing Remarks**

18.00 **Evening Public Lecture**
Shared Autonomy: The Future of Interactive Robotics
Professor Sethu Vijayakumar FRSE

Talk Abstracts

Robotic Tactile Sensing and e-skin Technologies

Dr Ravinder Dahiya

Tactile or electronic skin in robots and prosthetics is critical to explore, perceive and manipulate real world objects. In this direction, several technologies have been explored. This talk will present various approaches (over different time and dimension scales) for obtaining distributed electronics and sensors on flexible and conformable substrates, especially in context with tactile or electronics skin. These include distributed off-the-shelf sensors and electronic components, integrated on flexible printed circuit boards, to obtain large area tactile skin for robots and wearable systems. The advanced alternatives include printing of nanowires, ultra-thin chips and graphene-based energy-autonomous skin. Such sensitive electronics systems will be key enablers for numerous emerging fields such as wearable systems, the internet of things, smart cities and mobile health, etc. and this lecture will also discuss how the flexible electronics research may unfold in the future.

Endoscopic Surgery through Natural Orifices : a Perfect Case for Robotics in the Surgical Field

Professor Michel de Mathelin

The natural trend in surgery is to become less and less invasive, with more focused treatment, in order to limit the side effects to the patient. Natural orifice transluminal endoscopic surgery is a new, minimally invasive surgical technique based on the use of flexible endoscopes, with instruments going through a natural orifice of the patient inside the body. It is often called “no visible scar” surgery. However, the benefits for the patient are obtained at the expense of added complexity and dexterity for the surgeon. Robotics can bring down these barrers by providing computer assistance during surgery, as well as added dexterity through teleoperation. This talk will review ten years of research and development in this field by ICube laboratory robotics researchers at the University of Strasbourg, in collaboration with surgeons from the University Hospital of Strasbourg and IRCAD.

Establishing Trust in Autonomy Through Explainable AI

Professor Helen Hastie

We are seeing a rapid adoption of autonomous unmanned systems (AUS) in modern societies, from home robots to autonomous cars and drones, accelerated with the advent of deep machine learning. For example, the UK National Oceanographic Centre (NOC) now owns over 30 autonomous maritime vehicles that have become central to their ability to answer key scientific questions about the oceans, climate change and environment monitoring. AUS bring huge advantages in terms of reducing manpower and doing jobs in such hazardous and hard-to-reach environments. With autonomy, however, comes the need for trust in the system: that it is working as it should and progressing towards a shared goal. Also, in the future, human–machine teaming will be key and trust is an important commodity in this regard, because it allows the human to suspend the meticulous analysis of benefits and risks when cooperating with another and proceed with the task at hand. There is an important trade-off between control and trust in autonomy and one solution is for the system to explain its reasoning and actions, commonly referred to as Explainable AI. Prof. Hastie presents her work on communicating with AUS in natural language, as well as discussing advancements and challenges in Explainable AI for autonomy.

Tactile Perception In and Outside our Body

Professor Vincent Hayward

The mechanics of contact and friction is to touch what sound waves are to audition, and what light waves are to vision. The complex physics of contact and its consequences inside our sensitive tissues, however, differ in fundamental ways from the physics of acoustics and optics. The astonishing variety of phenomena resulting from the contact between fingers and objects is likely to have fashioned our somatosensory system at all levels of its organisation, from early mechanics to cognition. The talk will illustrate this idea through a variety of specific examples that show how surface physics shape the messages that are sent to the brain, providing completely new opportunities for applications of human machines interfaces.

Talk Abstracts

Reaching the Unreachable: The Science of Robot Locomotion

Dr Zhibin Li

Decades of research has been focused on robot locomotion. The goal of this field is to develop walking, running, leaping and climbing robots which can operate on a variety of terrains. Driving this push towards locomotion is the demand for robots to carry out tasks such as delivery and distribution in the real world. Yet, robot locomotion comparable with human level performance has not been seen outside the lab.

This talk will explore the state-of-the-art of robot locomotion–particularly legged robots, followed by the research challenges in planning and control. We will discuss technologies being developed in other fields which can transform hard challenges in robotics into solvable problems. Finally, we look at some useful robotic solutions that can be transferred to industrial applications with economic benefits.

Robotics: the Can Do and Can't Do

Dr Jean-Pierre Merlet

Robotics is presented as a fast evolving domain and, because of a long history, raises a lot of concerns that are fueled by hypothetical prospectives. In this talk, we will present the possibilities for modern robotics, emphasizing non-humanoid systems that may find their way in our society, in our home or work. The break of the barrier beetwen the robots' world and the human one also raises ethical and societal issues that have to be addressed, based on reasonable assumptions on the technical feasibility. These issues will be presented through practical problems.

Bipedal Walking: A Multidisciplinary Perspective

Professor Jean-Paul Laumond

The talk reports on a research action exploring the motor synergies of anthropomorphic walking. By combining biomechanical, neurophysiology and robotics perspectives, it is intended to better understand human locomotion, with the ambition to better design bipedal robot architectures. The motivation of the research starts from the simple observation that humans may stumble when following a simple reflex-based locomotion on uneven terrains. The rationale combines two well established results in robotics and neuroscience, respectively: first, passive robot walkers, which are very efficient in terms of energy consumption, can be modeled by a simple rotating rimless wheel; second, humans and animals stabilize their heads when moving. The seminal hypothesis is then to consider a wheel equipped with a stabilized mass on top of it as a plausible model of bipedal walking, the so-called Yoyo-Man. We will see recent results supporting this hypothesis. These results open new perspectives to explore the computational foundations of anthropomorphic walking and to design new humanoid robots.

Evening Public Lecture

Shared Autonomy: The Future of Interactive Robotics

Professor Sethu Vijayakumar FRSE, Professor of Robotics, University of Edinburgh, UK. Director, Edinburgh Centre for Robotics and Royal Academy of Engineering–Microsoft Research Chair in Robotics

The next generation of robots are going to work much more closely with humans and with other robots, and interact significantly with the environment around them. As a result, the key paradigms are shifting from isolated decision-making systems to one that involves shared control – with significant autonomy devolved to the robot platform; and end users in the loop making only high-level decisions.

This talk will introduce technologies ranging from robust multi-modal sensing and shared representations to compliant actuation and scalable machine-learning techniques for real-time learning and adaptation, enabling us to reap the benefits of increased autonomy while still feeling securely in control.

This also raises some fundamental questions; e.g., while the robots are ready to share control, what is the optimal trade-off between autonomy and control with which we are comfortable?
Domains where this debate is relevant include self-driving cars, mining, shared manufacturing, exoskeletons for rehabilitation, active prosthetics, large-scale scheduling (e.g., transport) systems, as well as oil and gas exploration, to list a few.

Speaker biographies

Dr Ravinder Dahiya, Professor of Electronics and Nanoengineering, University of Glasgow

Ravinder Dahiya is Professor of Electronics and Nanoengineering and EPSRC Fellow in the School of Engineering at the University of Glasgow. He is the Director of the Electronics Systems and Design Centre (ESDC) and the leader of the Bendable Electronics and Sensing Technologies (BEST) group. His group conducts fundamental research on high-mobility materials–based flexible electronics and electronic skin, and their application in robotics, prosthetics and wearable systems.

He has published more than 160 research articles, four books (three at various publication stages) and nine patents (including seven submitted). He has led many international projects.

He is a Distinguished Lecturer of IEEE Sensors Council and is on the Editorial Boards of *Scientific Reports* (Nature Group), *IEEE Transactions on Robotics* and *IEEE Sensors Journal*. He is the Technical Program Co-Chair (TPC) for the 2017 and 2018 IEEE Sensors Conferences.

Professor Dahiya holds a prestigious EPSRC Fellowship. In the past, he has received a Marie Curie Fellowship and a Japanese Monbusho Fellowship. He has received several awards; most recently the 2016 IEEE Sensor Council Technical Achievement Award and the 2016 Microelectronic Engineering Young Investigator Award. In 2016, he was included in the list of Scottish 40UNDER40.

Speaker biographies

Professor Michel de Mathelin, Strasbourg University

Michel de Mathelin received an Electr. Eng. degree from Louvain University, Louvain-La-Neuve, Belgium, in 1987 and MS and PhD degrees in electrical and computer engineering from the Carnegie Mellon University, Pittsburgh, PA, in 1988 and 1993, respectively. During 1991-1992, he was a Research Scientist in the Department of Electrical Engineering, Polytechnic School of the Royal Military Academy, Brussels, Belgium. In 1993, he became Assistant Professor at Strasbourg University, France. Since 1999, he has been Professor at TŽlŽcom Physique Strasbourg, University of Strasbourg. He was the Head of the Automation, Vision and Robotics research group (60 people) from 2000 to 2012. Since 2013, he has been the Director of the ICube Laboratory (UMR CNRS-UNISTRA 7357), with more than 650 people in the area of Engineering and Computer Science, with a strong focus on biomedical and environmental engineering. In 2017, he became Vice-President for Technology Transfer at the University of Strasbourg. Michel de Mathelin was Associate Editor of the IEEE *Control System Technology* Journal from 2003 to 2011. His current research interests include medical robotics, visual servoing, adaptive and robust control. He has co-authored more than 200 international refereed journal and conference papers. With his co-authors, he received the ICRA 2004 Best Vision Paper Award and the 2005 King-Sun Fu Memorial Best *IEEE Transactions on Robotics* Paper Award. He holds eight patents and is co-founder of Axilum Robotics, a startup in medical robotics. Dr. Mathelin is a Fellow of the Belgian American Educational Foundation.

Speaker biographies

Professor Helen Hastie, Professor of Computer Science, Heriot-Watt University
Helen Hastie is a Professor in Computer Science at Heriot-Watt University, Edinburgh and a RAEng/Leverhulme Trust Senior Research Fellow. She specialises in Human–Robot Interaction, in particular spoken dialogue, for a number for domains including health, defence and personal assistants. She was the coordinator of the EC FP7 project PARLANCE on voice-enabled search and Co-I for the EC FP7 Emote project on empathic robotic tutors. Recently, she has received funding from the UK MoD for her work on explainable autonomy. She has international experience in both academia and industry, having worked at AT&T Research Labs, NJ, USA, where she obtained a number of patents, and Lockheed Martin, NJ, USA, where she led the Interactive Systems group. Helen holds a PhD in Speech Recognition from the University of Edinburgh, an MS from Georgetown University and an MA from the University of Edinburgh. She has published over 80 papers and was a founding member of the RSE Young Academy of Scotland.

Professor Vincent Hayward, Professor (on leave), Université Pierre et Marie Curie (UPMC), Paris
Vincent Hayward is a Professor (on leave) at the Université Pierre et Marie Curie (UPMC) in Paris. He was previously with the Department of Electrical and Computer Engineering at McGill University, Montréal, Canada, where he became a full Professor in 2006 and was the Director of the McGill Centre for Intelligent Machines from 2001 to 2004. Hayward is interested in haptic device design, human perception and robotics; and is a Fellow of the IEEE. He was a European Research Council Grantee from 2010 to 2016. Since January 2017, Hayward has been a Professor of Tactile Perception and Technology at the School of Advanced Studies of the University of London, supported by a Leverhulme Trust Fellowship.

Speaker biographies

Dr Zhibin Li, Lecturer, University of Edinburgh
Dr Zhibin Li is a Lecturer in the Institute of Perception, Action and Behaviour (IPAB) in the School of Informatics, University of Edinburgh. Before that, he was with the Italian Institute of Technology (IIT) from 2009 to March 2016, where he obtained a joint PhD Degree in Robotics from IIT and the University of Genova, and then worked as a postdoctoral researcher leading the locomotion group at the Department of Advanced Robotics, IIT.

He is now the Head of the Advanced Robotics Lab in IPAB and his research focuses on a variety of control technologies involving robust control, optimisation and machine learning, for solving challenging problems in dynamic motion control and complex behaviours of legged robots, particularly humanoids.

Professor Jean-Paul Laumond, Directeur de Recherche, LAAS-CNRS
Jean-Paul Laumond, IEEE Fellow, is a roboticist. He is Directeur de Recherche at LAAS-CNRS in Toulouse, France. His research is devoted to robot motion. In 2000, he created and managed Kineo CAM, a spin-off company devoted to develop and market motion planning technology. Siemens acquired Kineo CAM in 2012. In 2006, Laumond launched the research team Gepetto, dedicated to human motion studies along three perspectives: artificial motion for humanoid robots; virtual motion for digital actors and mannequins; and natural motions of human beings. His current project, Actanthrope, is supported by the European Research Council (ERC). He teaches Robotics at the Ecole Normale Supérieure in Paris. He has published more than 150 papers in international journals and conferences in Robotics, Computer Science, Automatic Control and Neurosciences. He was the 2011–2012 recipient of the Chaire Innovation technologique Liliane Bettencourt at the Collège de France in Paris. Laumond is a member of the French Academy of Technologies. He was the 2016 recipient of the IEEE Inaba Technical Award for Innovation Leading to Production.

Speaker biographies

Dr Jean-Pierre Merlet, Senior Research Scientist, INRIA
J-P. Merlet is a senior researcher at INRIA, working in Sophia-Antipolis, where he leads the HEPHAISTOS team devoted to robotized assistance to frail people. He is the author of over 300 scientific publications in history, mechanism theory, robotics, physics, control and numerical analysis. He is an IEEE Fellow, Doctor *honoris causa* from Innsbruck University and the recipient of an IFToMM Award of Merits. He is a member of the IFToMM Executive Council and of the Academic Committee of Université Cote d'Azur. His current research interests are focused on assistance to frail people using non-intrusive and low-cost hardware, including robust functionnal assessment that may help the helpers and the medical community, with an emphasis on acceptance and ethics.

Professor Sethu Vijayakumar FRSE, Professor of Robotics, University of Edinburgh, UK. Director, Edinburgh Centre for Robotics and Royal Academy of Engineering–Microsoft Research Chair in Robotics
Sethu Vijayakumar is the Professor of Robotics in the School of Informatics at the University of Edinburgh and the Director of the Edinburgh Centre for Robotics. He holds the prestigious Senior Research Fellowship of the Royal Academy of Engineering, co-funded by Microsoft Research and is also an Adjunct Faculty of the University of Southern California (USC), Los Angeles. Professor Vijayakumar, who has a PhD (1998) from the Tokyo Institute of Technology, has pioneered the use of large scale machine learning techniques in the real time control of large degree of freedom anthropomorphic robotic systems including the SARCOS and the HONDA ASIMO humanoid robots, KUKA-DLR robot arm and iLIMB prosthetic hand. His latest project (2016) involves a collaboration with NASA Johnson Space Centre on the Valkyrie humanoid robot being prepared for unmanned robotic pre-deployment missions to Mars. He is the author of over 170 highly cited publications (h-index 35, citations > 5500, as of 2017) in robotics and machine learning and the winner of the IEEE Vincent Bendix award, the Japanese Monbusho fellowship, 2013 IEEE Transaction on Robotics Best Paper Award and several other paper awards from leading conferences and journals. He has led several UK, EU and international projects in the field of Robotics, attracted funding of over £38M in research grants over the last 8 years and has been appointed to grant review panels for the DFG-Germany, NSF-USA and the EU. He is a Fellow of the Royal Society of Edinburgh and a keen science communicator with a significant annual outreach agenda. He is the recipient of the 2015 Tam Dalyell Award for excellence in engaging the public with science and serves as a judge on BBC Robot Wars and was involved with the UK wide launch of the BBC micro:bit initiative for STEM education.

Notes

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