

# SMART INDUSTRY WORKSHOP

**Recent Advances in Industrial  
Digitalisation, Robotics and Automation**

**9-11 January 2019  
Nottingham Trent University, Nottingham,  
UK**

Organised and Sponsored by:

**NOTTINGHAM  
TRENT UNIVERSITY**

**connected  
everything.**  
industrial systems in the digital age

**CIA**  
Computational Intelligence &  
Applications Research Group

**XILINX**

**WORKSHOP WEBSITE**

**SMARTINDUSTRY4.UK**

# INTRODUCTION

Computing and communication systems are advancing at an incredible pace with recent advances achieving effective and ubiquitous results at all levels of modern society. The current stage of globalisation, a.k.a Globalisation 3.0 means that science, scientists, manufacturing and operators are even more distributed across a global geographical span rather than locally.

As industrial systems and processes evolve, research students and early career researchers in computer science, engineering and manufacturing must keep up to date with how computational intelligence, machine learning and connected devices are helping to shape the future of our smart industry.

The aim of this workshop is to present rigorous scientific advances accompanied by real-world applications in the areas of Industrial Digitisation, Robotics and Automation. This will include presentations of recent advances in tools and techniques for the design and development of embodiments for the smart industry. In a smart industry, devices not only react to events through sensing, interpretation and service provision, but also learn and adapt their operation and services over time. These embodiments employ contextual information when available, as well as offering unobtrusive and intuitive interfaces.

We bring key academic and industry experienced speakers to inform and inspire the future generations of roboticists and cybernetic experts. This workshop will bring a multidisciplinary audience interested in understanding Computational Intelligence and Cognitive Robotics by considering ideas and topics presented by our prestige set of speakers.

Smart Industry Workshop 2019 will take place at Nottingham Trent University, located conveniently within the Clifton Campus of the University, a short journey from the Nottingham city centre and all tourist attractions. The workshop features 13 keynote talks by established researchers and it also provides the opportunity to the researchers to share their research experiences.

**Ahmad Lotfi**

General Chair, Smart Industry Workshop

# KEYNOTE TALKS

## S1: Human Factors for the Future Workforce

**Prof Neil Mansfield, Nottingham Trent University**

**Topic Summary:** – There is a current move towards industrial digitization, where digital systems will become ubiquitous across all industrial applications. This has been expressed in terms of the ‘4th Industrial Revolution’, or Industry 4.0. The move towards cyber-physical systems in the workplace means that robots will become more intelligent and potentially adaptable using AI / deep learning. They will be more capable of carrying out more complex tasks for smaller volume processes thereby increasing their versatility. By being cloud networked, data streams can be accessed from anywhere and production control manipulated remotely. Industry 4.0 is about the integration of other technologies including the internet, computing, robotics, big data, neural networks, and ergonomics / human factors. The fear that jobs will be ‘taken away’ from the future industrial worker is naïve, although it is true that some existing manual tasks will, in future, be completed by machines and individual cases of human redundancy will inevitably prove controversial. Future jobs will continue to evolve, as they have throughout the centuries. Future workers will be employed in an environment where all businesses will become increasingly digitized. Cobotics will become the norm whereby humans will work alongside robots. Cobots have already been introduced in some warehouses to assist with picking and transport (e.g. Next clothing; Arla milk) and there is a move towards including robots in manufacturing. This presents a challenge of Situation Awareness both for the human and for the AI of the robot. Human factors need to be at the core of developments in Smart Industry in order for this to improve human experience and well-being; much is already understood but this needs to be acknowledged and applied in order for Industry 4.0 to be exploited to its full potential.



**Speaker’s Bio:**- Neil is Professor and Head of Engineering at Nottingham Trent University UK, where he leads an ambitious new department seeking to create a new breed of engineers ready to invent our future world. This initiative gives equal weight to the fundamentals of engineering and to creative project delivery. Prior to working at Nottingham Trent he was a Professor at Imperial College London where he helped set up a School of Design Engineering, and was Associate Dean for Research at Loughborough Design School. He has a long track-record in the world of Ergonomics and Human Factors Engineering, having completed his PhD in Biomechanics of Humans Exposed to Vibration and Shock, and research on optimisation of well being for those working in challenging environments, ranging from military and off-road machinery through to design to maintain the independence of the oldest car drivers. He previously chaired the ISO committee tasked

with writing standards on whole-body vibration, and was editor of the journal Ergonomics for 10 years. He is now President of the Chartered Institute of Ergonomics and Human Factors.

## S2: The Future of Robotic Agriculture

**Prof Tom Duckett, University of Lincoln**

**Topic Summary:** -Agri-Food is the largest manufacturing sector in the UK, twice the scale of automotive and aerospace combined. It supports a food chain that generates over £108bn p.a., with 3.9m employees in a truly international industry and exports £20bn of UK manufactured goods. However, the global food chain is under pressure from population growth, climate change, political pressures affecting migration, population drift from rural to urban regions and the demographics of an aging global population. To meet these challenges, this talk reviews the state of the art and future opportunities in the application of robotics and autonomous systems (RAS) in Agri-Food production. I will further present the latest results from current research projects at the University of Lincoln, including robotic systems for soil, water and crop management, intralogistics and human-robot collaboration for Agri-Food production.



**Speaker's Bio:-** Tom Duckett is Professor of Robotics & Autonomous Systems at the University of Lincoln, UK, where he also leads the Lincoln Centre for Autonomous Systems. His research interests include autonomous robots, artificial intelligence, machine perception, and robotic mapping, with applications including agri-food and service robotics. He has been an investigator in many national and international research projects, funded by the European Commission, the UK Research Councils and Innovate UK, including ILIAD, STRANDS, and various ongoing projects in precision agriculture.

### **S3: Synchronizing Distributed Multi-Static Radar/Communication Nodes for Vital Monitoring**

**Dr Julien Le Kernec, University of Glasgow**

**Topic Summary:** – Radar frontends pushed by the squeeze in spectrum resources now reuse frequencies for radars operating in the same vicinity. As the number of radar units operating in the same vicinity increases, radar need to communicate between each other and dynamically change function from surveillance, tracking and identification to reporting and nulling interferers for counter measures. This requires two main components synchronization of clocks for coherence in multi-static operation over the air with high precision to measure rib cage and heart displacements and also dynamically steerable antenna arrays to focus on the target while in motion or mobile to maintain activity monitoring and extract as many vital sign information as possible with affordable units.



**Speaker's Bio:-** Dr Julien Le Kernec received his B.Eng. and M.Eng. degrees in electronic engineering from the Cork Institute of Technology, Ireland, respectively, in 2004 and 2006, respectively, and his Ph.D. degree in electronic engineering from University Pierre and Marie Curie, France, in 2011. He held a post-doctoral position with the Kuang-Chi Institute of Advanced Technology, Shenzhen, China, from 2011 to 2012. He was a Lecturer with the Department of Electrical and Electronic Engineering, The University of Nottingham Ningbo China, from 2012 to 2016. He is currently a Lecturer with the School of Engineering in the Systems, Power and Energy Group within the communications, sensing, imaging lab, University of Glasgow. His research interest includes radar system design, software defined radio/radar, signal processing, and health applications.

### **S4: Tactile Sensing and its Value in Robotic, Industrial and Medical Applications**

**Dr Emmett Kerr, Ulster University**

**Topic Summary:** – Humans perceive the world through information gathered by their five senses. Attempting to replicate some of these senses in intelligent systems has been a focus of research for many years. Tactile sensing enables the measurement of attributes of objects, materials and the environment that cannot be determined by vision sensing alone such as compressibility, thermal properties or sub-surface vibration. Accurate and effective tactile sensing capabilities will play a vital role in robotics-based assistive living, search and rescue and smart manufacture. This talk will discuss the advantages of tactile sensing and its applications. Methods for identifying objects and materials from tactile sensing will be discussed together with the utilisation of machine learning approaches and their potential applications to assistive living and smart manufacture. The capability of sub-surface vibration measurement and highly accurate material surface analysis could be heavily utilised in industrial manufacturing processes. Furthermore, this talk will present recent contributions in the field of tactile sensing that demonstrate that a robotic system can determine a human's status of health. The use of a robot hand and a biomimetic sensor to accurately measure the vital signs of a human by mimicking medical professionals will be discussed. It will be outlined how these methods are being utilised in ongoing projects aimed at developing safe and monitored living environments for older people and people with disabilities whilst maintaining their anonymity. This research will play a vital role in improving assistive living technologies and making them available to elderly and disabled persons worldwide, improving their quality of life, safety and independence.



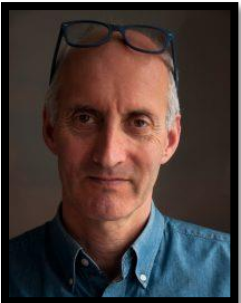
**Speaker's Bio:-** Dr. Emmett Kerr received a BEng (Hons) in Mechanical and Manufacturing Engineering from Queens University Belfast, UK in 2005. He was a project engineer, co-managing over €7.5 million in projects, and later a Mechanical Engineering Supervisor for the Smurfit-Kappa Group from 2005-2009. He then returned to research work and his studies and received a MSc with distinction in Computing and Intelligent Systems from the Ulster University, UK. He graduated with his PhD in Robotics in 2018, also from the Ulster University, UK. Emmett reached the top 10 of the EPSRC UK ICT Pioneers competition in 2015 for his PhD work in developing a robotic system that can measure human vital signs in a similar manner to medical professionals. Emmett won the Derry JCI Ten Outstanding Young Persons (TOYP) award in 2018 for the category of Scientific and/or technological development. He is a lecturer in Mechanical Engineering in the School of Computing,

Engineering and Intelligent Systems and a researcher in The Intelligent Systems Research Centre in Ulster University, Magee Campus. Emmett has been involved in the submission of numerous grant proposals and worked on numerous research projects, including the IM-CLeVeR and VISUALISE FP7 EU projects. He is author or co-author on 16 research papers. Emmett's research areas include Robotics, Tactile Sensing, Artificial Intelligence, Robotics for Vital Sign Monitoring and Assistive Living, Advanced Automation, Smart Manufacture.

## S5: The Challenges of Building Robots

**Mr. Tim Jones, CEO of Intelligent Machines Ltd.**

**Topic Summary:** -We live in changing times and most-likely this century will probably be known for the robotics revolution. Robots have long borne the potential to bridge the gap between the cybernetic world (the internet of things) and the physical world. What is a robot? In this talk, I will share 4 decades of experience building robots as an innovator in unconventional markets, with lessons learnt (often the hard way).



**Speaker's Bio:-** Tim Jones is a mechatronics designer/inventor with a degree in Mechanical Engineering from Aston University and a Masters degree in Industrial design from the Royal College of Art. He has been designing novel robots, actuators and products for over 40 years and has many patents to his name. His fascination with robotics stems from early childhood, producing a line following robot at the age of 12. But it was the inspirational comment from a fashion designer at the RCA that really triggered his robotics career... "Wouldn't it be great if mannequins moved in shop windows". The invention of a pneumatic muscle and the creation of a low cost robotic arm with ten degrees of freedom resulted and was the star of his degree show, powered by an Acorn System One with 1kB of memory! He founded The Original Android company and built an Android using pneumatic amplification of low powered radio control servomotors as a means to provide position control. He was co-

founder of Universal Machine Intelligence Ltd a venture capital backed Personal Robot company that pioneered low cost robotic arms the RTX and RT100. These became popular in many universities for teaching and research purposes particularly in fabric handling and rehabilitation projects. He later co-founded Oxford Intelligent Machines Ltd (OxIM), a robotics and automation consultancy which took over and further developed the RT100 which was used in the EU RAID and EPIRAID projects for assisting Quadriplegics. OxIM also was a partner in the EU Robofish1 & 2 projects concerned with the robotic de-heading of fish. A novel 'whirling dervish' robot was created for the Robofish 1. A novel pen testing robot was created for a client and finally a bun handling Cartesian direct drive robot was designed and part developed with a specification to pick up and package 24,000 buns an hour. Following on from OxIM and as an independent consultant, he designed and built a down-hole prototype robot for locating and measuring the perforations in oil wells. He developed and patented a harmonic linear drive (HLD) actuator which was used as to actuate an early version of OC Robotics' Snake robot. The HLD was licensed to and sold by Animatics Inc (now part of Moog Inc). Most recently he founded Intelligent Machines Ltd and has been involved in the design and development of robotics in carbon tow deposition and nuclear pellet handling. Robotics remains a passion for him particularly outside the traditional manufacturing industries.



## S6: Mimicking Brain-Like Repair to Build Future Smart, Self-X Embedded Systems

**Dr Jim Harkin, Ulster University**

**Topic Summary:** – One of the key advantages of neural network hardware is its implementation via massive parallelism of small, regular computations rather than as a complicated microprocessor. Fault tolerance naturally arises in neural networks from the distributed and parallel computation over many synapses and neurons. Exploring the use of new emerging self-repair spiking neural networks, which capture the structural and signalling repair mechanisms e.g. astrocyte cells used in biology, enable us to push the ‘reliable’ capability significantly further. Using these advanced spiking neural networks in hardware we can significantly increase their tolerance to failure by enabling self-detection, self-diagnosis, self-repair – ultimately self-X capabilities. This talk will outline advances in capturing this self-X capability in spiking neural networks and also the progress in addressing the hardware interconnect challenge for such networks using networks-on-chip. Recent results will demonstrate the self-X capabilities in FPGA hardware, and some early progress will be presented on exploiting spiking neural networks in the self-detection and self-adaption to traffic congestion and security attacks in networks-on-chip.



**Speaker’s Bio:-** Jim Harkin is a Reader at Ulster University and Associate Head of School of Computing, Engineering and Intelligent Systems. His research focuses on the design of intelligent embedded systems to support self-repairing capabilities and hardware/software implementations that emulate the computational and fault tolerance capabilities of biology. His work has seen innovations in Networks-on-Chip strategies and the hardware implementation of self-repairing Spiking Neural Networks. His research has been supported by Research Council UK and local government (DETI, InvestNI and DEL) and has published over 100+ articles. He is Associate Editor for IET Computers and Digital Techniques, Associate Member of EPSRC Peer-Review College, and Member of the IEEE Circuits and Systems Society (CASS) Sensory Systems Technical Committee (TC) and Neural Systems and Applications TC.

## S7: Industry 4.0: Balancing on the Edge

**Prof. Anne James-Taylor, Nottingham Trent University**

**Topic Summary:** – The extension of the Cloud to the Edge of the network through Fog Computing can have a significant impact on the reliability and latencies of deployed applications. Recent papers have suggested a shift from Virtual Machine and Container based deployments to a shared environment among applications to better utilize resources. Unfortunately, the existing deployment and optimization methods pay little attention to developing and identifying complete models of such systems. This failing can cause large inaccuracies between simulated and physical runtime parameters. Existing models do not account for application interdependence or the locality of application resources. This talk addresses such issues and proposes a method of developing suitable and more accurate models. A new reference model is proposed with data driven parameter formulations and representations to help understand the effect of migration. As a result, a more complete characterization of the fog environment is provided. This, together with optimization methods can instruct application deployment and migration and improve the overall system reliability, delay and constraint violations. An Industry 4.0 based case study with different scenarios is used to analyse and validate the effectiveness of the proposed model.

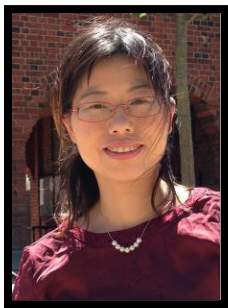


**Speaker’s Bio:-** Anne is Professor and Head of Department of Computing & Technology. Previous to her current role, Anne was Professor of Data Systems Architecture at Coventry University. She obtained her BSc degree at Aston University, UK and her PhD at the University of Wolverhampton UK. Specialising in data processing and semantic analysis, the research interests of Professor James are in the general area of creating distributed and intelligent systems to meet new challenges, particularly in the area of cyber security. Examples of current projects are the development of enhanced methods for detection of biometric identity fraud, the construction of new methods for Cloud forensics, the use of block chain technology, and natural language processing for document content analysis. Professor James has successfully supervised 30 research degrees and has published around 200 papers in peer reviewed journals or conferences.

## S8: Smart Sensors with AI techniques

**Dr Shufan Yang, University of Glasgow**

**Topic Summary:** -Sensors have become ubiquitous in every industry now, including image sensors, optical sensors and novel developments such as quantum sensors. Unlike traditional sensors which only includes of the mechanical and electronic properties. State-of-art sensors include the data processing requirements and data fusion and artificial intelligence (AI) techniques. The last few years have seen the emergence of artificial neural network techniques, meaning that sensing systems routinely become smart. This talk covers the ramifications of advanced techniques, and includes guidance on design of sensor systems in this context. It also covers on my active research on radar sensing and image sensing using one of complex recurrent neural networks; discusses the integrate of computation, neural network architectures and evaluations in order to apply artificial intelligent system using time series sensor data.



**Speaker's Bio:-** Dr Shufan Yang is currently a lecturer in Embedded Intelligent Systems with School of Engineering, University of Glasgow, United Kingdom. She received the Ph.D degree in Computer Science from the University of Manchester in 2010, MSc (2003) and Bcs (1998) from the Hunan University, China. She has was responsible for system on-chip connection design on EPSRC SpiNNaker project from 2006 – 2010 and pioneering research on inhibitory control neuron circuit in FP7 ImClever projects from 2010 to 2012. Her research interests include system-on-chip, artificial neural networks, embedded systems and multicore processes.

## S9: Forestry 4.0 — Going Beyond Smart Agriculture

**Dr João Filipe Ferreira, Nottingham Trent University**

**Topic Summary:** – Forestry, the practice of creating, managing, using, conserving, and repairing forests, woodlands, and associated resources — has a substantial weight in the economy of many industrial countries, the importance of which is often overlooked. It provides direct economical gains, but also societal and environmental benefits. Unfortunately, for all its potential, forestry is currently a risky investment with very slow returns. Therefore, widespread long-term conservation and management of forestry resources has been hard to gain traction, and in many countries forestry is seen more as a strategic commitment for the future than an investment in the present. The consequent increasing lack of manpower due to low salaries (especially taking into account the harshness of its operations), and also the progressive abandonment of rural areas and of practices such as pastoralism, has driven forestry to become increasingly mechanised to increase productivity. In fact, the human operator will soon turn into a bottleneck for making machines even more efficient. One way of solving this problem would be by introducing and developing (semi-)autonomous vehicles and robots, which would potentially reduce running costs and remove the many health hazards involved in forestry. However, despite many advances in key areas, the development of fully autonomous robotic solutions for precision forestry is still in a very early stage. In this talk, I will present the first steps of ongoing research projects at the University of Coimbra, Portugal. I will be specifically discussing the advances proposed to the state-of-the-art on one of the most crucial challenges in the application of robots to forestry — artificial sensing and perception.



**Speaker's Bio:-** Dr João Filipe Ferreira is a Lecturer/Senior Lecturer in Computer Science at Nottingham Trent University (NTU) since 2018. He is as an integrated member of the Artificial Perception for Intelligent Systems and Robotics team (AP4ISR, team manager in 2016) of the Institute of Systems and Robotics (ISR), a research institute of the University of Coimbra, and also as a member of the Computational Neuroscience and Cognitive Robotics Laboratory (CNCR) at NTU. His main research interests are artificial cognition, probabilistic modelling and autonomous systems, with a special emphasis on bioinspired perception. He is the main author of the 2014 textbook “Probabilistic Approaches for Robotic Perception” (Springer STAR series). He is a member of the IEEE Robotics and Automation Society since 2012 (RAS – currently an Executive Committee member of the Portuguese Chapter), and a member of the IEEE RAS Technical Committee on

Cognitive Robotics since 2015. He has been involved in several FP6, FP7 and H2020 European projects developed in consortium over the past few years and was recently the PI of the nationally funded research project CASIR – Coordinated Control of Stimulus-Driven and Goal-Directed Multisensory Attention Within the Context of Social Interaction with Robots (FCT Contract PTDC/EEI-AUT/3010/2012). He is currently the local PI for the FEDER/PORTUGAL 2020-funded projects SEMFIRE (Safety, Exploration and Maintenance of Forests with the Integration of Ecological Robotics – CENTRO-01-0247-FEDER-032691) and CORE (Centre of Operations for Rethinking Engineering – CENTRO-01-0247-FEDER-037082), both running from 2018 to 2021.

## S10: Real-Time Modelling of Visual Scenes with Biological Inspiration

**Dr Kofi Appiah, Sheffield Hallam University**

**Topic Summary:** – Targets of atypical size relative to their surrounding objects are usually missed by humans during visual search; studies show that this isn't necessarily a deficiency but a useful strategy to discount distractors. These characteristics may explain why the human visual system works very well with processing of complex information in real time and can detect moving objects whilst in motion. At present, the standard approach for detecting moving objects in a video scene can be achieved with either the unsupervised background subtraction approach with stationary cameras or the supervised state-of-the-art deep neural networks (DNN) with moving cameras. However, DNN guarantees the detection of only known objects with no sense of understanding the scene. The increasing popularity of using non-stationary cameras by several security agencies means that video data will have some elements of movement. Therefore, methods for reliably and robustly modelling of a video scene which uses a moving camera are in great demand. This talk will focus on how objects in a scene can be modelled with inspiration from psychology as well as biological vision system.



**Speaker's Bio:-** Kofi Appiah received a master's degree in computer science from Oxford University in 2003; a Ph.D. in computer science from Lincoln University in 2010, after working on various embedded computer vision projects as a research assistant at Aston University (Photonics Research Group), Durham University (Computer Vision Group) and University of Essex (Embedded and Intelligent Systems Group). He is currently a senior lecturer at Sheffield Hallam University. Before joining Sheffield Hallam University in 2017, he worked at Nottingham Trent University as a lecturer from 2013. Kofi's current research focuses on the interface between embedded computer vision, machine learning and neuroscience; mainly to understand and model the biological vision system on parallel architectures like Field Programmable Gate Arrays (FPGA). He has published more than 40 peer-reviewed academic papers and serve as a reviewer for several core journals, such as

Computer Vision and Image Understanding, IEEE Transactions on Neural Networks and Learning Systems, PLOS ONE, and more. In 2009, he won the IEEE Computational Intelligence Association Outstanding Student's Award; in 2015, he secured a fully funded PhD studentship as a director of studies; and in 2017, he received the Sheffield Hallam University Higher Education Impact Research Fellowship to work with Sundance Ltd.

## S11: Hands-On Workshop Using a Low Power And High Performance Embedded Computing Platforms

**Mr Flemming Christensen, CEO of Sundance Multiprocessor Technology Ltd.**

**Topic Summary:** – Sundance is currently in the process of designing a platform for "Robo + Agri" and the workshop will give attendance a chance to try their hands on such a system that has Xilinx MPSoC FPGAs, using the [www.tulipp.eu](http://www.tulipp.eu) toolchain.





**Speaker's Bio:-** Sundance was founded by Flemming Christensen in 1989 with the focus on design, manufacturing, and testing of electronics modules based on a leading-edge Multiprocessing technology that allowed infinitive scaling of processing power. The advances in silicon technology have come to a level where more integration does not result in better performance per CPU, so the requirement for Multiprocessing in any Image/Vision/Robotics application/appliance is now again the only option for future portable and low-cost systems. The focus of Sundance is still Multiprocessing Technology and our keyword technologies/interest are: 1. Vision System and sub-components for safety; 2. Advanced Sensor technology for monitoring; 3. Robotics electronics for unmanned vehicles.

## S12: Corobotics and Automation – A Spinal Surgery Case Study

**Prof Philip Breedon, Nottingham Trent University**

**Topic Summary:** – Surgical robotics are at the forefront of developments in surgery. There are several international developments currently on going, many of which have proven the benefit of intra-operative surgical assistance. The *ScoliBOT* is the system name for a relatively inexpensive surgical Corobotics system that will place drill guides through a plate that has been previously (in the same surgical procedure) attached to the spine by the surgeon. Utilising CT scan data the robotic arm will be able to sense any movement and respond to this ensuring that drilling by the robotic arm is extremely accurate. Where the development also differs from current surgical navigation techniques is that custom 3D printed implants (anchors) have been developed to attach to individual vertebrae. The workflow would be to attach and lock the implants in place (surgeon) – placement would be precise due to the exact contour fit of the anchors. The robot system would then recognise the markers on the implants and identify which vertebra it is attached to, it would attach itself to the anchor and drill and screw through the anchor into the vertebra along the pre-planned path eliminating human imprecision. Finally the robot would move along pre-planned virtual pathways to allow deformity reduction – again this would occur with more precision and control removing human interaction. Once the desired manipulation is complete the surgeon would fix the construct in place by connecting the anchors with rods.



**Speaker's Bio:-** Philip Breedon is Professor of Smart Technologies at Nottingham Trent University and is the director of the Medical Design Research group. He is a member of the Department of Health's National Institute for Health Research invention for innovation funding panel (NIHR i4i) and holds a number of journal editorial positions. His research interests and latest projects centre on new and emerging technologies and materials. This includes wearable technologies, 3D printing of pathological models, additive and subtractive manufacturing for medical applications, surgical robotics, cardiovascular devices, augmented /virtual/immersive technologies and environments, and investigative research related to the utilisation of 'smart materials' for medical applications. He and a multidisciplinary research team are working on the development of a number of medical device applications, which includes NIHR funded research projects relating to wearable technology for facial weakness rehabilitation and patient maintained sedation. Through promoting his work and research activities he now works with a number of surgeons and clinicians across Europe and recently gave keynote lectures at the NSpine conference in London on both surgical robotics and additive manufacturing for medical devices. He was invited, and consequently visited six NASA centres across the USA to discuss potential collaborative research opportunities and to examine the latest materials and technology research and its applications.

## S13: How Robots Are Changing Our World: Assistive Robotics

**Prof. Ahmad Lotfi, Nottingham Trent University**

**Topic Summary:** – Robotics for healthcare is an emerging field which is expected to grow considering the demographic change and increase in the older adults' population, expected shortages of healthcare personnel, calls for improving quality of life for the elderly and disabled, and the need for even higher quality care, for example, high precision surgery. All these factors have made a significant contribution to innovation and innovative solutions. Reported major innovations are in five themes; robotics for medical interventions; robotics supporting professional

care; robotics assisted preventative therapies and diagnosis; robotic assistive technology and robotics for rehabilitation treatment. An overview of assistive robotics and how they are changing the provision of the care is presented in this talk.



**Speaker's Bio:** - Prof. Ahmad Lotfi is a Professor of Computational Intelligence at Nottingham Trent University, where he is leading the research group in Computational Intelligence and Applications. Areas of research include Machine Learning and Computational Intelligence; Assistive Technologies; Robotics; Smart Homes and Smart Cities; and Data Mining and Analytics. He has worked in collaboration with many healthcare commercial organisations and end-users including Tunstall Healthcare Group and Nottingham Adult Care. He has received external funding from Innovate UK, EU and industrial companies to support his research. He has authored and co-authored over 150 scientific papers in the area of computational intelligence, abnormal behaviour recognition and ambient intelligence in highly prestigious journals and international conferences. He has been invited as an Expert Evaluator and Panel Member for many EU Framework Research

Programmes including [FP6/FP7](#) [ERC](#) and Horizon 2020.

## S14: Advancing the Science of Daily Activities with Cognitive Robotics

**Dr Diego R. Faria, Aston University**

**Topic Summary:** – Research advances in cognitive robotics and the development of new technologies are allowing the introduction of assistant and service robots in our daily lives. To create such applications, a robot should be able to co-exist and co-operate with the human presence in a friendly way. For this to happen, a number of issues need to be solved, including modelling and recognition of human daily activity, behaviour analysis and emotional expressions in order to establish an affective loop between humans and robots, aiming at a proper communication through Human-Robot Interaction (HRI). Human behaviour and emotional expression are topics pursued by multidisciplinary fields such as psychology, computer science and engineering, including cognitive robotics. Cognitive robotics is concerned to endow a robot with intelligent behaviour, where robots can learn from experience, from human teachers, and even on their own, thereby developing the ability to effectively interact with the human's environment. In addition, a robot endowed with the ability of analysing verbal and non-verbal behavioural cues displayed by humans, can also infer the underlying communicated affect. In the latter, an affectively competent AI agent exploits human emotional expressions and behaviours to successfully interact with them; the perception and interpretation of different states through different body expressions allows an artificial agent to act more socially and engage with humans more naturally. A robot capable to understand human daily activities and expressions can increase its own capability to solve problems by using these knowledge in its decision making process, similarly as humans do. This talk will focus on showing recent advances of human daily activity recognition and emotional expressions by highlighting each component of the perception-reasoning-(int)action loop, showing all steps since data acquisition, processing, learning and recognition using real robots. The key points to be discussed are the role of artificial perception and machine learning in cognitive robotics in contexts of behaviour analysis an emotional expressions towards advancing the social HRI. Different techniques and a proposed framework for human daily activity and emotional expression recognition will be presented.



**Speaker's Bio:** -Dr Diego R. Faria is a Lecturer in Computer Science at the School of Engineering and Applied Science of Aston University, Birmingham, UK, since July 2016. He received his Ph.D. degree in Electrical and Computer Engineering (topic of cognitive robotics) from the University of Coimbra, Portugal, in 2014. During 2014 to 2016, he carried his research as postdoctoral fellow at the Institute of Systems and Robotics, University of Coimbra within the Automation and Robotics for Human Life group. In the past, he collaborated on multiples large-scale integrated EU projects, and projects funded by the Portuguese foundation for science and technology on topics of socially assistive robotics, artificial perception and applied machine learning for human-robot interaction, grasp and dexterous manipulation, and pedestrian detection for autonomous vehicles. In 2017, he had the concession of a grant funded by the SEAS-Aston University to launch

and coordinate the Artificial Intelligence & Robotics (AIR) club to prepare Aston University's undergraduate and postgraduate students to apply AI concepts into practice using real robots as an extracurricular activity. Currently, he is the project coordinator and principal investigator of an EU project (CHIST-ERA programme, EPSRC-UK funding Aston University €450K, total budget €1.3M): InDex – Robot In-hand Dexterous manipulation by extracting data from human manipulation of objects to improve robotic autonomy and dexterity. His research interests are: Socially

## S15: PS-based Intelligent Firefighting Robot Systems

**Prof Hongnian Yu, Bournemouth University**

**Topic Summary:** – As the fast development of Artificial Intelligence and robotics, robots are not only applied in the manufacturing factories, but also are gradually applied in medical and service industry and search and rescue tasks in the emergency environment. On the other hand, urbanisation and changes in modern infrastructure have introduced new challenges to firefighting practices. The current manual operations and training including fire investigation, hazardous chemicals detection, fire and rescue are insufficient to protect the firefighter's safety and life. The firefighting and rescue functions of the existing equipment and apparatus and their dexterity are limited, particularly in the harsh firefighting environments. The existing firefighting robots are facing the following challenges: 1) cannot enter the fire field to perform tasks; and 2) cannot provide real-time information support of the fire field. This talk will first introduce the history of robotics and its classifications. In particular HAM (Human Adaptive Mechatronics) developed from one of my network projects is introduced and discussed. Then the challenges and future researches of robotics in disaster rescues (in particular fire-fighting) are revealed. It will address the part of the above challenges and will provide a review on the robot-assisted firefighting systems with interdisciplinary perspectives to identify the needs, requirements, challenges as well as future trends to facilitate smart and efficient operations. We will consider information acquisition (sensing and visioning technology), transmission (ultra-remote signal transmission) and processing (multi-sensor fusion technology), instrumentation (actuating technology, robotics thermal protection technology), control (multi-degree of freedom mobile and operating robot control methods, obstacle avoidance and sweeping, Decision Support Systems (DSS)) and communication (Human-Robot (H2R) interaction systems, Machine-to-Machine (M2M)). This talk will also introduce the basic requirements to design and develop a hybrid mobile robot and report the recent progress conducted by the EU funded SMOOTH project. Subsequently, prevailing firefighting robotic platforms in literature as well as in practices are elaborately scrutinized and discussed, followed by investigation of localization and navigation support methods.



**Speaker's Bio:-** Professor Hongnian Yu has successfully supervised over 20 PhD theses and over 20 Master by Research theses, and has examined over 30 PhD/MPhil students' theses as both internal and external examiner. He has trained 12 post-doctoral research fellows. He has published over 200 journal and conference research papers. He has held several research grants worth about eight million pounds from the UK EPSRC, the Royal Society, and the European, AWM, as well as from industry. He has managed several international large consortiums as a coordinator. Examples are 1) coordinator (PI) of an EPSRC funded £158K international network project on Human Adaptive Mechatronics which includes 7 Japanese partners and 7 UK partners; 2) coordinator of the EU funded 3.05 million Euro Erasmus Mundus FUSION project which has 20 international partners; 3) coordinator of the EU funded one million Euro Marie Curie project, etc. Prof Yu has strong research collaboration with partners from over 30 countries, such as China, France, Germany, Hungary, India, Italy, Japan, Romania, Thailand, and UK. He was awarded the F.C. William Premium for his paper on adaptive and robust control of robot manipulators by the IEE Council, and has received two best conference paper awards, seven best (student) conference paper awards with his research students. He has won the Gold Medal on The World Exhibition on Inventions, Research and New Technologies, INNOVA 2009, Brussels, and International Exhibition of Inventions, Geneva, Switzerland, 2010, for invention "Method and device for driving mobile inertial robots"; and the 43rd International Exhibition of inventions, New Techniques and Products, in Geneva, 2015. He is serving on 3 editorial boards and has served on numerous international conference organization committees, e.g. IPC co-chair of the UKACC, Cardiff, 3-5/09/2012; General Chair of the International Conference on SKIMA, China, 9-11/09/2012; 15-17/12/2016; General co-chair of the International Conference on Advanced Mechatronic Systems, China, 25-27/09/2013; Japan 10-12/08/2014; China 22-24/08/2015 etc. He is a member of the EPSRC Peer Review College and the IeT Fellow.

# PROGRAMME

	<b>Wednesday 9 January 2019</b>	<b>Thursday 10 January 2019</b>	<b>Friday 11 January 2019</b>
Time/Room	<b>Pavilion – PAV123</b>	<b>Pavilion – PAV123</b>	<b>Pavilion – PAV123</b>
9:00 – 9:30	Registration	Registration	Session 11 - Mr. Flemming Christensen - Xilinx hands-on FPGA and Embedded SoC design training using the Sundance VCS-1.
9:30 - 9:45	Welcome and Introduction – Prof. Mark Biggs and Prof. Sarah Sharples	Robotics Lab visit – Mr. Pedro Machado	
9:45 - 10:30	3 minutes PhD Pitches	3 minutes PhD Pitches	
10:30 - 11:00	Coffee Break		
11:00 - 11:45	<b>Session 1:</b> Prof. Neil Mansfield - Human Factors for the Future Workforce	<b>Session 6:</b> Dr. Jim Harkin - Mimicking brain-like repair to build future smart, self-X embedded systems	<b>Session 12:</b> Prof. Philip Breedon - Corobotics and automation – a spinal surgery case study
11:45 - 12:30	<b>Session 2:</b> Prof. Tom Duckett - The Future of Robotic Agriculture	<b>Session 7:</b> Prof. Anne James - Industry 4.0: Balancing on the Edge	<b>Session 13:</b> Prof. Ahmad Lotfi - How Robots Are Changing Our World: Assistive Robotics
12:30 - 13:30	Lunch + Poster Viewing		
13:30 - 14:15	<b>Session 3:</b> Dr Julien Le Kernec - Synchronizing distributed multi-static radar/communication nodes for vital monitoring	<b>Session 8:</b> Dr. Shufan Yang - Smart sensors with AI techniques	<b>Session 14:</b> Dr. Diego Faria - Advancing the science of daily activities with Cognitive Robotics
14:15 - 15:00	<b>Session 4:</b> Dr Emmett Kerr - Tactile Sensing and its value in robotic, industrial and medical applications	<b>Session 9:</b> Dr João Filipe Ferreira - Forestry 4.0 – Going Beyond Smart Agriculture	<b>Session 15:</b> Prof Hongnian Yu - PS-based Intelligent Firefighting Robot Systems
15:00 - 15:30	Coffee Break		Prize Giving for the Best Poster and the Best Presentation
15:30 - 16:15	<b>Session 5:</b> Mr. Tim Jones - The challenges of building robots	<b>Session 10:</b> Dr. Kofi Appiah - Real-Time Modelling of Visual Scenes with Biological Inspiration	Closing
16:15 - 17:00	Panel session I	Panel session II	

# PARTICIPANTS

<b>Name</b>	<b>Affiliation</b>	<b>Category</b>
Dr Diego Faria	Aston University	Speaker
Dr Jim Harkin	Ulster University	Speaker
Prof Hongnian Yu	Bournemouth University	Speaker
Dr Kofi Appiah	Sheffield Hallam University	Speaker
Mr Flemming Christensen	Sundance Multiprocessor Technology	Speaker
Prof Tom Duckett	University of Lincoln	Speaker
Prof Phil Breedon	Nottingham Trent University	Speaker
Prof Anne James	Nottingham Trent University	Speaker
Prof Neil Mansfield	Nottingham Trent University	Speaker
Prof Ahmad Lotfi	Nottingham Trent University	Organisation/Speaker
Dr Shufan Yang	University of Glasgow	Speaker
Dr Julian Le Kenec	University of Glasgow	Speaker
Dr Emmett Kerr	Ulster University	Speaker
Mr Tim Jones	Intelligent Machines	Speaker
Dr João Filipe Ferreira	Nottingham Trent University	Speaker
Pedro Machado	Nottingham Trent University	Organisation/PhD student
Dr. Aboozar Taherkhani	Nottingham Trent University	Early-carer researcher
Amirkhashayar Naderian	Nottingham Trent University	PhD student
Ashiqur Rahman	University of Lincoln	PhD student
Dr Ashith R Babu	University of Lincoln	Early-carer researcher
David Adama	Nottingham Trent University	PhD student
Ghayth AlMahadin	Nottingham Trent University	PhD student
James Thorp	Lancaster University	PhD student
Juan Parra	Aston University	PhD student
Jun Hao Alvin Ng	Heriot-Watt University	PhD student
Kieran McMullen	University of Sheffield	PhD student
Matthew McGuigan	University of Exeter	PhD student
Dr Md Nazmul Huda	Coventry University	Early-carer researcher
Melanie Zimmer	Loughborough University	PhD student
Nabila Naz	Queen Mary University of London	PhD student
Nikesh Lama	Nottingham Trent University	PhD student
Nikolai Kazantsev	Alliance Manchester Business School	PhD student
Okechukwu Okorie	Cranfield University	PhD student
Dr Pengcheng Liu	University of Lincoln/ Cardiff Metropolitan University	Early-carer researcher
Ruidong Xue	Aston University	PhD student
Salisu Yahaya	Nottingham Trent University	PhD student



Tariq Masood	University of Cambridge	PhD student
Zheqi Yu	University of Glasgow	PhD student
Terence Sweeney	Ulster University	PhD student
Huseyin Celikag	University of Sheffield	PhD student
Dario Ortega Anderez	Nottingham Trent University	PhD student
Dr David Sanderson	University of Nottingham	Early-carer researcher
Hatem Fakhuruldeen	University of Bristol	PhD student
Kuba Sanak	Heriot-Watt University	PhD student
Hector Montes	University of Lincoln	PhD student

# DELEGATE INFORMATION

**Access times:** the opening hours for the Pavilion Building, Nottingham Trent University are Monday-Thursday (7:30 am – 8:00 pm) and Friday – Saturday (7:30 am – 7:30 pm). Should you require access outside of these times then prior arrangements would need to be made via the organiser.

**Car Parking:** Free car parks are available to all visitors. Please contact the organiser ([smartindustry4@ntu.ac.uk](mailto:smartindustry4@ntu.ac.uk)) to reserve a visitor car park for you.

**Fire Alarm:** In the event of a fire alarm, please evacuate the building via the nearest exits. The university has dedicated Fire Marshalls who will ask you to wait at an assembly point. Note, the Pavilion building fire system test will take place every Friday between 8 am and 9 am.

**Printing:** If you require printing, please contact the event organiser.

**Reception:** the contact reception during the workshop, please dial **83899** from an internal telephone or telephone Nottingham Trent University main switchboard on 0115 941 8418.

**Audio visual equipment:** All AV equipment is tested prior to your arrival. If you are using AV equipment and counter a problem, please contact our AV support team or the event organiser. The login details on all university computers is **Username:** ntpresent and **Password:** present

**WiFi:** To access NTU's WiFi, please select "ntu-guest" from the list of options and follow the instructions.

**Non-smoking venue:** Nottingham Trent University is a non-smoking venue. Smoking is permitted offsite on Goldsmith Street, away from the entrance and steps.

## VENUE MAP



**Smart Industry Workshop will be held in Pavilion Building (PAV123)  
Clifton Campus, NG11 8NS**