Centre for Robotics & Sensors technologies (CRS) Mini-Workshop

Time: 10.00 am to 17.30 pm on 7 February 2020

Venue: G8, Edinburgh Napier University, Merchiston Campus, 10 Colinton Road, Edinburgh EH10 5DT

9.40 – 10.00: Tea/Coffee and networking and collaboration activities

10.00 – 10.30

1. **Requirements of IoT in industry and the related challenges**

Ian Smith, Abelon Systems Ian Smith is Managing Director and co-Founder of Abelon Systems

Summary: The talk will address the following practical questions

- Very brief introduction to Abelon Systems
- Examples of some of our typical IoT customer project scope
- Some real world challenges of these projects and how we have overcome them

Brief CV: Ian Smith, Abelon Systems Ian Smith is Managing Director and co-Founder of Abelon Systems, an embedded systems design consultancy based in Edinburgh, Scotland. As Managing Director Ian provides Abelon with experienced business and technical leadership, and he has experience leading and implementing complex technical projects on a national and international scale. A veteran of Silicon Glen and the telecoms industry, Ian has helped Abelon to acquire a reputation for providing customers with innovative solutions and the application of telecoms and networking technologies across a variety of market sectors, and this innovative thinking has led to a number of awards for clients. Ian is a regular guest lecturer at Heriot Watt University, sharing his experience with future engineering talent. Ian has a BSc (Hons) in Electrical and Electronic Engineering from Heriot-Watt University, an MBA from the University of Edinburgh, and is a Chartered Engineer

10.30 – 10.45

2. **Talk Title:** Design of a Subsurface Wireless Sensor System for Challenging Water Utility Environment.

Dr Chan H. See, BEng, PhD, CEng, FIET, FHEA, SMIEEE, Associate Professor, School of Engineering and the Built Environment

Summary - The sewerage network in the U.K., at 302 000 km in length, is one of the largest infrastructures within the water industry. These assets are aging and are also subject to increasing capacity demands because of the increased urbanization, more stringent environmental regulation, and the projected consequences of climate change. To proactively reduce their risk of failure and become more operationally efficient, water companies are exploring with organizations, including academia and instrumentation manufacturers, to find solutions for improving the efficiency of responses to failures of key elements of critical infrastructure. In this talk, it will cover the design,

development and implementation of a low-cost and power efficient wireless sensor mesh networking communication system for providing adequate warning on potential blockage incidents to prevent sewer failure. Throughout the field trial, the performance of the proposed system in terms of durability of sensors, sensor nodes and gateways and reliability of wireless communication under real operational condition was characterized. Problems encountered and lessons learned from the sensor deployment process will be discussed.

Brief CV - Chan H. See received the first class B.Eng. honors degree in electronic, telecommunication, and computer engineering and the Ph.D. degree in computational bioelectromagnetics from the University of Bradford, Bradford, U.K., in 2002 and 2007, respectively. He is an associate Professor in the School of Engineering and the Built Environment, Edinburgh Napier University. He also is a Visiting Research Fellow in the School of Engineering and Informatics, University of Bradford and School of Engineering, University of Bolton. Previously, he was a Senior Lecturer, in University of Bolton and a Senior Research Fellow in the Antennas and Applied Electromagnetics Research Group within the University of Bradford. His research interests cover wireless sensor network system design, computational electromagnetism, antennas, and acoustic sensor design. He has published more than 200 peer-reviewed journal articles and conference papers. He is a coauthor of one book and five book chapters. He received two Young Scientist Awards from the International Union of Radio Science and the Asia-Pacific Radio Science Conference in 2008 and 2010, respectively. He received a certificate of excellence for his successful Knowledge Transfer Partnership with Yorkshire Water on the design and implementation of a wireless sensor system for sewerage infrastructure monitoring in 2009. Dr. See is a Chartered Engineer in the U.K., Senior Member of Institute of Electrical and Electronics Engineers, US and a Fellow of the Institution of Engineering and Technology, U.K. He is also a Fellow of The Higher Education Academy and an Associate Editor for IEEE ACCESS.

10.45 – 11.30

3. **Talk title: Artificial Intelligence in Computer-Automated Design and Creativity for Industry 4.0**

   Professor Yun Li, Professor Yun Li FIEEE, Director, Dongguan Industry 4.0 Artificial Intelligence Laboratory

Summary: The progress of science and technology now heavily relies on simulation-based 'third paradigm of science' and data-driven 'fourth paradigm of science'. This talk will focus on transforming the third-paradigm 'computer-aided design' (CAD) to the fourth-paradigm 'computer-automated design' (CAutoD), in relation to artificial intelligence and, in particular, computational intelligence. Such a development is indispensable for the fourth, and the first a-priori engineered, industrial revolution ('Industry 4.0', or 'i4'). So far, what are lacking in i4 is an 'intelligent design' tool customized for mass production commensurate with an 'intelligent manufacturing' value chain and 'market informatics' at the end of the value chain of i4, both of which factory-floor innovation needs to take into account in order to deliver transformative gains in performance, productivity and time to market. Today, using 'smart simulation' and cyber-physically connected CAutoD will upgrade the manufacturing value chain at the dawn of Industry 4.0, for 'smart manufacturing'. With computational intelligence, this talk will explore how to utilize artificial evolution to achieve smart simulation and virtual prototypes for i4-ready mass-customization designs with enhanced innovation, creativity and competitiveness. It will include examples of intelligent grey-box modelling, symbolic simulation, and high-performance computing CAutoD. The talk will conclude with a

summary of intelligent modelling and optimization challenges, opportunities and future directions presented by Industry 4.0 and how we may best capitalize on them in China-Europe research collaboration.

Brief CV: Yun Li received the B.S. degree in electronics science from Sichuan University in 1984, the M.E. degree in electronic engineering from University of Electronic Science and Technology of China in 1987, and the Ph.D. degree in parallel computing and control from University of Strathclyde in 1990.

In 1989, he was Control Engineer with the U.K. National Engineering Laboratory. In 1990, he was Postdoctoral Research Engineer with Industrial Systems and Control Ltd, Glasgow. From 1991 to 2018, he was Lecturer, Senior Lecturer and Professor with University of Glasgow and served as its Founding Director of University of Glasgow Singapore. He is currently the Founding Director of Dongguan Industry 4.0 Artificial Intelligence Laboratory and a Distinguished Professor with Dongguan University of Technology, China.

Since 1991, his research interest has been computational artificial intelligence and its applications. He is the author of the popular 1997 online interactive courseware for evolutionary algorithms, EA_demo (http://i4ai.org/EA-demo/). He has published 270 papers, one in IEEE TSMC-B being among the top 5 and another in IEEE TCST the most popular every month.

Prof. Li is a Fellow of the IEEE and an Associate Editor of the IEEE TEVC, IEEE TNNLS, and IEEE TETCI. He is a Fellow of the Royal Society of Arts in the U.K. and has co-led the EPSRC's key programme "Industrial Systems in the Digital Age". He chaired the funding council's "Looking Beyond Industry 4.0" conference in Glasgow in 2017.

11.30 – 12.15

4. **Title: Duality of learning in autonomous agents**

Dr. Michael Herrmann, University of Edinburgh

I will review the principle of homeokinesis as a general approach to active learning in autonomous robots. The prinicple establishes a balance between exploration and exploitation within a regime of critical behaviour. In addition, the formation of internal representations of the sensorimotor loop will be considered, where the role of machine learning techniques in robotics will be evaluated. Finally, an information-theoretic interpretation of active learning will be outlined and compared to recent reinforcement learning algorithms.

Brief CV: Dr. Michael Herrmann received a Diploma (1988) from the University of Leipzig and a Doctorate for the same institution (1993). He was working as a research assistant from 1992 and as a postdoc in Denmark and Japan. His PhD focused on mathematical aspects of artificial neural networks. In 2008, after a temporary position as an assistant professor at the University of Goettingen, he was appointed to the post of Lecturer in Robotics at the School of Informatics at the University of Edinburgh. He has taught courses on reinforcement learning, on natural computing, artificial intelligence, and an introductory course on vision. His research interests include swarm robotics, adaptive control and optimisation.

12.15-13.00

5. **Talk Title: Intelligent Autonomous Pollination for Future Farming**

Dr Leo Chen FIMechE, FHEA, SMIEEE, MIET, Senior Lecturer in Engineering Design , School of Engineering, Newcastle University

Summary: Food security is one of the societal challenge topics. As one-third of all food consumed by humans relies on animal pollination currently, this research provides an emerging solution to food supply reduction caused by population shrinking of natural pollinators, so as to reduce its impact on ecological relationships, ecosystem conservation and stability, genetic variation in the crop plant community, floral diversity, specialisation and evolution. This paper develops a conceptual technical roadmap of autonomous pollination for future farming using robotic micro air vehicle pollinators (MPrs). The research provides new insights into autonomous design and manufacture and into possible ways to increase the production efficiency, which shortens the time from lab to market. The autonomous MPrs are realized using artificial intelligence and human expertise in the loop for smart agricultural industry. Further, this work identifies scientific and technological advances that are expected to translate, within proposed regulatory frameworks, into the pervasive use of MPrs for agricultural applications and beyond.

Brief CV: Dr Leo Chen (BSc, MSc, PhD, CEng, FIMechE, FHEA, SMIEEE, MIET) received the B.Sc. degree in automotive engineering from the Chongqing University of Technology, in 2000, the M.Sc. degree in automotive engineering from Chongqing University, in 2004, and the Ph.D. degree in mechanical engineering from the University of Glasgow, in 2010. He has a high-level output of research publications in leading international journals and presentations at international conferences, which related to the research area of robotics, digital manufacturing, and industry 4.0, which demonstrates significant research and grant potential in engineering and cross-disciplinary applications. He is a member of IET, AAAI, AIAA, and ASME, a Fellow of HEA, and a Fellow of IMechE. He is also a Chartered Engineer. He has published over 100 academic articles in both high-impact international academic journals and international conferences and has been selected as a Publons' top 1% of reviewers in computer science and engineering. He has been actively involved in both academic research and KTP projects as a PI and a CoI funded by EPSRC, U.K., Horizon2020 (EU), NSFC, China, the National Key Research and Development Program of China, and industrial funding bodies. One of the co-organizers of the WCCI'16 Special Session on Computational Intelligence for Industry 4.0 and the CEC'19 Special Session on Evolutionary Computation for Creativity, Manufacture and Engineering Management in the Industry 4.0 Era. Besides, he is an Editorial Board Member, and he has been a Guest Editor for five special issues.

13.00 – 13.15

6. **Topic**: Title: Automated systems for pathogen detection.

Dr. Abdel Fateh Kerrouche, Lecturer in Electronic and Electrical Engineering

Summary: In this talk, I will present current projects related to pathogen detection in water. I will show recent developments in integrated platforms:

Aquaculture : Development Of An Early Warning System For Pathogen Detection In Aquaculture Facilities. In this project, we are designing a standalone system to monitor the quality of water inside the fish farming tanks. The system is based on microfluidic technology and a microscopic camera.

Pathogen detection in drinking water: We are currently designing a fully automated system for pathogen detection from a large volume of water (e.g. 1000L) based on filtration process, ultrasonic transducers and microfluidics technology. The system has a potential to reduce the cost of detection and to better inform water companies for public health decisions.

Bathing water: Design a smart system for pathogens detection using deep learning in bathing waters. The overall aim of this research (Fully funded PhD) is to prototype an on-site monitoring system for E. coli in bathing water

Objective 1: to develop a setup for obtaining images of suitable quality from the microfluidic channel which will allow the detection of E. coli by Image Processing and Deep Learning Algorithms.

Objective 2: to test the set-up with water samples containing a variety of concentrations of microbeads (1-5 µmetres) to simulate E. coli

Brief CV: Dr. Abdelfateh Kerrouche is affiliated to School of Engineering and The Built Environment, Edinburgh Napier University. He is currently providing services as Lecturer. He has published numerous publications in various national and international peer-reviewed journals and presented scientific papers across the world. Because of the active association with different societies and academies as well as the contributions, he is been recognized by the subject experts around the world. Dr. Kerrouche contributions are appreciated by various reputed awards. Dr. Kerrouche clinical and scientific research interests include Centre for Algorithms, Visualisation and Evolving Systems.

13.15 – 14.00: Lunch break and networking and collaboration activities

14.00 – 14.45

7. **Title: Intelligent Vision System for Object Detection and UAV Landing in Challenging Environments**

Dr Erfu Yang, Department of Design, Manufacturing and Engineering Management, University of Strathclyde

Summary: Within the oil and gas industry, robotic systems have been seen more popular both in onshore and offshore applications for many reasons. The inspection of key assets in the oil and gas industry is critical both for safety and business reasons. Moreover, recent developments in autonomous robots have enabled machines with greater levels of flexibility and adaptability, allowing them to perform various tasks more efficiently than the human counterpart. Unmanned aerial vehicles (UAVs) in particular have emerged as highly agile systems that can be deployed to perform lightweight tasks quickly and efficiently. In this talk, a vision system for object detection and UAV landing in a challenging environment with non-uniform changing conditions is presented. A practical case study is conducted on a quadrotor (DJI F450 flame wheel quadcopter frame with Pixhawk autopilot) to perform a real-time landing area and defects detection and path planning in the workspace. The developed vision system is able to detect, track the defects and dynamic landing areas by only using a 2D bounding box with its centroid given and the low-cost image acquisition devices (webcams). Feeding into a light Convolutional Neural Networks (CNN), it can differentiate the challenging target under different background and lighting conditions. A key feature is to change some 3x3 convolution filters to 1x1 convolution filters for the purpose of efficient implementation. What is more, the number of channels that are input to the 3x3 convolutional filters are decreased to reduce computing

complexity. Another key feature is that the Kalman filter is exploited for supervising the target. Preliminary experiments and live demonstrations show that a relatively robust performance for object detection and tracking integrated with robot control and path planning is satisfactory, even in challenging conditions such as vision obstruction and illumination changing. The proposed system can be further enhanced by exploiting more efficient image processing algorithms at speeding up CNN.

Brief CV: Dr Erfu Yang is a Lecturer under Strathclyde Chancellor's Fellowship Scheme. His main research interests include robotics, autonomous systems, computer vision, image/signal processing, mechatronics, data analytics, manufacturing automation, multi-objective optimizations, and applications of machine learning and artificial intelligence including multi-agent reinforcement learning, fuzzy logic, neural networks, bio-inspired algorithms, and cognitive computation, etc. He has over 130 publications in these areas, including more than 70 journal papers and 10 book chapters. He received the Best Paper Award at the 2019 UK EPSRC Robotics and Autonomous Network (UKRAS) Conference on Embedded Intelligence. He has been awarded over 27 research grants as PI (principal investigator) or CI (co- investigator). He is a Fellow of the UK Higher Education Academy, committee member of the Chinese Automation and Computing Society in the UK (CACSUK), and the IET SCOTLAND Manufacturing Technical Network. Dr Yang has been a Scientific/Technical Programme Committee member or organizer for a series of international conferences and workshops. He has also served for many international journals and conferences as a scientific reviewer. He was a Literature Surveyor for the leading International Journal of Adaptive Control and Signal Processing (published by Wiley). He is now an associate editor for the Cognitive Computation journal published by Springer. He was also the guest editor of the International Journal of Automation and Computing for its Special Issue on Emergent Control and Computing Techniques for Industrial Applications.

14.45 – 15.00

8. **Talk Title**: From Control System to Renewable Energy, Robotic, Battery and Beyond

Dr Keng Goh, School of Engineering and the Built Environment, Edinburgh Napier University

Summary - Control System – Modelling, simulation and implementation of control technique in diesel generator control and fault diagnosis

Renewable Energy – Wind turbine modelling and control

Robotic – rotorcraft landing on uneven surfaces

New challenges:

- Smart manufacturing system
- Battery project

Brief CV - Dr Keng Goh received the B.Eng (Honours) first class degree in Electrical and Electronic from the University of Leicester, UK in 1998. After a period of work in industry (Hewlett Packard Ltd) supporting and developing test system for optical encoder, he returned to University of Leicester where he was awarded Scholarship to further his study in PhD research on Fault Diagnosis and Control of a Diesel Generator Using Sliding Mode Techniques. After the completion of research study, he joined Heriot-Watt University in 2003 as a post doctoral researcher, working on a research project: Design of control system for vector-controlled induction machine. In 2005, he joined Edinburgh Napier University and also hold an MBA degree. His main research interests are in control system design (using nonlinear control technique), automation and robotic control,

autonomous system, electric car, renewable energy resources, in particular control of wind turbine. Keng delivers a number of undergraduate and postgraduate modules in the School of Engineering and the Built Environment. He is also Programme Leader for the following Postgraduate Programmes:- MSc Renewable Engineering and MSc Automation and Control

15.00 – 15.45

9. Title: Creative Design of Conventional and Multi-mode Parallel Mechanisms

Dr Xianwen Kong FASME, FHEA, Lecturer, School of Engineering and Physical Sciences, Heriot-Watt University

Summary: Mechanisms are the backbone of robots, Robot mechanisms have evolved from serial mechanisms, parallel mechanisms to reconfigurable mechanisms during the past three decades to meet the need of systems that can adapt to production and environment change as well as multi-function products. Multi-mode parallel mechanisms are novel reconfigurable parallel mechanisms that are disassembly-free and use a minimum number of actuators. One multi-mode parallel mechanism can act as two or more conventional parallel mechanisms. This talk mainly covers a brief introduction to conventional parallel mechanisms and reconfigurable parallel mechanisms, an overview of creative design of conventional parallel mechanisms, creative design of multi-mode parallel mechanisms, and reconfiguration analysis of multi-mode parallel mechanisms based on quaternions and tools from computer algebraic geometry.

Brief CV: Dr Xianwen Kong is a lecturer and Programme Co-director of MSc Robotics at Heriot-Watt University, UK and a member of Edinburgh Centre for Robotics. His research interests include mechanisms and robotics focusing on the creative design of parallel manipulators with their applications in manufacturing and renewable energy. He has authored or co-authored one monograph, two US patents and more than 200 publications in journals and conference proceedings. The Russian translation and Chinese translation of the monograph were published by the Russian publisher FIZMATLIT – Nauka Publishers and the China Machine Press in 2012 and 2013 respectively. Dr Kong served as the Program Chair/Co-chair for the ASME/IEEE ReMAR in 2009, 2012 and 2015 and the ASME IDETC 2016 and 2018. He was an invited lecturer for the International Summer School on Screw-Theory Based Methods in Robotics hold in Italy, China, Brazil and Canada from 2009 to 2016. He is a Fellow of ASME and an elected member of the ASME Technical Committee on Mechanisms and Robotics and serves as an associate editor for *ASME Journal of Mechanisms and Robotics*, *Mechanism and Machine Theory* and *Mechanical Sciences*, a member of editorial board of the *Chinese Journal of Mechanical Engineering*. He received several awards including the 2012 Freudenstein/General Motors Young Investigator Award. A morphing machine developed by Dr Kong's team was on display in the Science and Technology Galleries at the National Museum of Scotland from July 2016 to February 2017 for creating spark of interest that leads to new discoveries.

15.45 -16.00

10. Talk Title: Environment and tools recognition for Home IOT Robot System

Peiliang Wu, Professor of School of Information Science and Technology, Yanshan University, Academic Visitor of Edinburgh Napier University, Postdoctoral Fellow of Institute of Automation, Chinese Academy of Sciences

Abstract: It is well known that the rapid development of artificial intelligence has greatly improved the intelligence of robot, and more and more high-intelligent robots in movies are appearing in our

daily life. Yet home service robot cannot provide confluent and pleasant service, one of the biggest challenges is that robot cannot recognize household environment and tools widely and deeply. In order to make home service robot recognize environment and manipulate tools like nanny, we combine IOT and home service robot to build the Home IOT Robot System, and research on 1) home cognition map, 2) room knowledge library and 3) tool knowledge library. We firstly propose the concept of simultaneous localization, calibration and mapping of the IOT robot system, with two kinds of map forms (i.e., two-dimensional vector map and three-dimensional holographic map), and two kinds of IOT robot system forms (i.e., Kinect network robotic system and wireless sensor network robot system). Under the Home IOT Robot System, we research on the semantic representation model of household tools affordance, the perspective-independent method for human behaviour recognition, and skill self-learning algorithm for service robots with reinforcement learning and imitation learning.

Biography: Peiliang Wu is currently a Professor of School of Information Science and Technology, Yanshan University, an Academic Visitor of Edinburgh Napier University, and a Postdoctoral Fellow of Institute of Automation, Chinese Academy of Sciences. He received his Ph. D. degree from Yanshan University in 2010. His main research interests include home service robot, robot operation skill learning, computer vision, SLAM, Multi-Agent systems, Intelligent Space, industrial assembly line optimal scheduling, competitive multi-robot Association, etc. He has published over 50 journal and conference research papers and 1 book in these areas. He has held several research grants from the National Natural Science Foundation of China, Natural Science Foundation of Hebei Province of China, China Postdoctoral Science Foundation, National key research and development program of China, as well as from industry, in which the Natural Science Foundation of Hebei Province of China was selected as the outstanding project in 2018.
In recent years, Peiliang Wu has guided postgraduates and undergraduates to participate in international robot Olympic competition, national robot championship, university robot competition of five provinces in North China and other discipline competitions, and won one world champion, one world runner up, more than ten national and provincial champions. He has rich experience in practice and guidance. In 2018 and 2015, he was awarded as Excellent Instructor of five provinces in North China.

16.00 - 16.15

11. **Title**: Multi-Functional MetaStructures for Healthcare Applications

Dr. Luigi La Spada, School of Engineering and the Built Environment, Edinburgh Napier University

Summary – Electromagnetic metamaterials have recently become one of the most active research topics in the areas of engineering, chemistry, biology and biomedicine. The main reason for this interest is that these engineered materials display novel and enhanced properties compared to traditional ones, paving the way for the development of new technological applications. In the last few years, such materials have acquired robust characterization and design tools, and novel fabrication techniques have been developed. Many exotic electromagnetic effects, which initially belonged to theory, are now well understood and are practically used in different applications. While metamaterials are mostly associated with electromagnetism or optics, the same concepts can be also applied to areas such as thermodynamics, classical mechanics, acoustics and fluid dynamics. The possibility of using a single material to control and manipulate at will any kind of wave is of great interest in many research field. It brings lots advantages in different industrial applications.

In this 10 minutes talk, my aim is to cover recent progress and novel trends in the fields of Multi-Functional Metastructures as the building blocks of present and future medical devices. Multi-purpose metamaterials will aid in the development of new and low-cost diagnostic and therapeutic tools, having a huge impact on the healthcare sector in the coming years.

Brief CV – Dr. Luigi La Spada received his BSc and MSc degree, summa cum laude, in Electronic Engineering and Information Communication Technology, from Roma Tre University (Italy), in 2008 and 2010, respectively.
In 2014, he received his PhD (scholarship winner) in Electronic Engineering (Section: Biomedical Electronics, Electromagnetics, and Telecommunications) from RomaTre University (Italy) and University of Pennsylvania, UPenn (USA). From 2014 to 2017, he worked as a Postdoctoral Research Assistant in the School of Electronic Engineering and Computer Science at Queen Mary University of London (UK). From 2018, he currently is Assistant Professor in the School of Engineering and the Built Environment at Edinburgh Napier University.
He has a high-level research outputs in leading international journals and high-ranked international conferences, related (but not limited) to its main research interest areas such as: metamaterials, metasurfaces, and plasmonics; photonics and nanoscale optics; advanced multi-functional and multi-physics materials and their applications in sensing, imaging and diagnostics. He published over 50 academic articles in both high-impact international academic journals and international conferences. In 2018 the Advances in Engineering (Canada) committee selected him as a "key scientific contributor to excellence in science and engineering research". His research received international scientific recognition and high distinction on several media press (i.e. CNN, CBS, Times, Aspen Institute). He is the recipient of different awards, among them: 2017 URSI Young Scientist Award (Canada), 2017 IEEE Young Scientist Award (second place), 2016 ISAP Best Paper Award (Japan) and 2015 EAI recognition for "new technologies in telecommunications and sensing".
He has been actively involved in academic research and consulting projects as both Co-Investigator and Project Manager, securing sources of funding for a total of 3M£ from funders such as from EPRSC, Horizon-2020 and CHIST-ERA. He attracted sponsorship, projects and contracts from international Universities (Universite' Grenoble Alpes, University of Toulouse, University of Macau Taipa) and Industries (Thales Alenia Space, Selex, Leonardo, Catapult, DSTL, BAE). In addition to this, he is Advisory Panel Member for the Institute of Physics (IoP, UK), Review Board Member for high-impact factor international Journals, and Guest Editor of special issues.

16.15 – 16.45

12. Title: The Nature-Inspired Intelligent System Group within the School of Computing

Summary: The Nature-Inspired Intelligent System Group within the School of Computing use bio-inspired mechanisms which are applied to a range of robotics applications, including swarm-robotics, human-robot interaction, and automated design and manufacture of robots. The talk briefly introduces recent research and some currently funded projects. In the context of swarm robotics, we will highlight recent work that uses a quality-diversity evolutionary algorithm to generate a repertoire of diverse but high-performing behaviours across a swarm in a completely decentralised manner; the repertoire can be used to optimise the composition of a swarm for a given situation. We will describe ongoing work on a 4 year EPSRC funded project collaborating with University of York and the West of England called Autonomous Robot Evolution: from cradle to grave, in which an evolutionary framework is used in conjunction with 3-d printing and an autonomous assembly arm to design both the morphology and controllers of robots. Finally, we will describe a recently funded New Investigator grant in the field of human-robot interaction which

focuses on the use of natural-language coupled with computer vision to enable a robot to make sense of the world around it.

Brief CV: Dr Andreas S.W. Steyven is a lecturer in data engineering in the School of Computing. He has established and currently runs the Evolutionary Robotics laboratory (Applied AI lab) to be used for research and teaching. Andreas graduated from the University of Applied Science in Koblenz, Germany, with a BEng in Electrical Engineering. His bachelor thesis was part of a Siemens research project in wireless automation technology. He also holds a BSc (with Distinction) in Engineering Studies with a focus on embedded systems and signal theory, as well as an MSc in Applied Informatics with a focus on network security and forensics from Edinburgh Napier University. He was awarded a PhD for his work entitled "A Closer Look at Adaptation Mechanisms in Simulated Environment-Driven Evolutionary Swarm Robotics". Furthermore, he is a trained and certified System and Network Administrator and has held several responsibilities in IT support in the automotive industry. His research interests lie in biologically inspired computing and robotics, especially in learning in self-organising and self-adaptive systems. Andreas also has an interest in cyber-physical systems, real-time control systems, smart homes and IoT.

16.45 – 16.55

13. **Title: Smart Manufacturing with AI and Robotics**

Ryan Samson, School of Engineering and the Built Environment

Summary: In this presentation I'd like to take the opportunity to introduce my PhD topic, I am due to start this project in the near future. As it stands, the project scope is wide and requires some work to narrow. Industry is currently going through a new revolution (Industry 4.0), transforming factories into smart environments by utilizing many new tools and methods. Various engineering approaches are being constructed to improve industrial environments. Traditional factories are evolving into smart environments by increasing flexibility throughout the manufacturing process along with continually developing techniques for process optimisation. The use of autonomous robotics in a manufacturing environment is one method for process optimisation: a key factor for smart factory transformation. However, existing manufacturing plants suffer from poor integration of autonomous vehicle(s) solutions to assist with task load and transformation into a smart environment. A key objective of the proposed research includes management of multi-autonomous robot systems in a smart factory environment. Collaboration between robots in the environment to improve overall system flexibility.

Brief CV: Ryan Samson; received BEng in Electrical Engineering and MSc in Autonomation and Control from Edinburgh Napier University. Received BEng in 2017 and MSc in 2018. Since then I have been assisting the SEBE at ENU with teaching and development of undergraduate and postgraduate programs. Part of the work includes assisting James McWhinnie with the development of the robotics laboratory at Napier University. This work has further sparked my interest in robotics along with my interest in research. Following this I recently applied to study a PhD research programme at ENU resulting in a very appreciative application success. This program will allow me to pursue my career ambition in becoming an academic with a strong research credential. This ambition is fuelled with interests that accumulated over the years from personal and academic levels.

16.55 – 17.05

14. Title: Smart Robot Systems for Firefighting Tasks

Professor Hongnian Yu BEng, MSc, PhD, FIET, FRSA, Head of Research, School of Engineering and the Built Environment, Edinburgh Napier University

Summary: 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.

Brief CV: Professor Hongnian Yu has successfully supervised 20 PhD theses and 18 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 a member of the EPSRC Peer Review College, Fellow of the IeT, Fellow of the RSA, and senior member of IEEE.

17.05 – 17.30 pm: Research collaborations & RACI conference