# Technologies and Applications for Closed-loop Neural Interfaces

Monday 13th and Tuesday 14th May 2024
Henry Royce Hub Institute, Oxford Rd, Manchester M13 9PY
https://newcastleuniversity.zoom.us/j/82523150456 **code: 619141**

## Day 1: Monday 13th May

### Welcome

| Time | Talk (25 minutes + 5-minute discussion) | Speaker |
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| **10:30 – 11:00** | **Coffee** | |
| 11:00 – 11:15 | Welcome | **Andrew Jackson**<br>Newcastle University |
| 11:15 – 11:45 | Overview of Engineering challenges in closed loop systems | **Alex Casson**<br>University of Manchester |
| **Session 1: Models enabling early and rapid technology development** | | |
| 11:45 – 12:15 | Ex vivo perfusion models | **James Fildes / Kavit Amin**<br>Pebble Biotechnology |
| 12:15 – 12:45 | Using multi-modal models to understand and improve the clinical utility of cochlear implants | **Iwan Roberts**<br>University of Cambridge |
| **12:45 – 13:15** | **Lunch (Mezzanine level)** | |
| 13:15 – 13:45 | On trials and tribulations – Safer, faster, and more sustainable medical devices for better and more equitable care | **Alex Frangi**<br>University of Manchester |
| 13:45 – 14:15 | Discussion – Where next with modelling | |
| **Session 2: Electrodes, instrumentation, and systems** | | |
| 14:15 – 14:45 | Future of flex: Stretchable patch to monitor muscle performance and injury shielding | **Samit Chakrabarty**<br>University of Leeds |
| 14:45 – 15:15 | Nerve conduction studies | **Leen Jabban / Maria Petrou / Mafalda Ribeiro**<br>University of Bath |
| 15:15 – 15:30 | **Coffee break (Mezzanine level)** | |
| 15:30 – 16:15 | **Royce tours** | |
| 16:15 – 16:45 | Medical microelectronics: From cleanroom to the brain | **Hadi Heidari**<br>University of Glasgow and Neuranics Limited |
| 16:45 – 17:30 | Discussion – Technology gaps | |
| **17:30** | **Close** | |

**End of Day 1**

| Day 2: Tuesday 14th May | | |
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| **Welcome** | | |
| **Time** | **Talk (25 minutes + 5-minute discussion)** | **Speaker** |
| **08:30 – 09:00** | **Coffee (Mezzanine level)** | |
| **Session 3: Control theory and machine learning for neurotechnologies** | | |
| 09:00 – 09:30 | Holistic mind control theory | **Long Zhang**<br>University of Manchester |
| 09:30 – 10:00 | Wearable intelligent neuroimaging for health and beyond | **Hubin Zhao**<br>University College London |
| 10:00 – 10:30 | Tiny Models on Tiny Wearable for Personalized Healthcare and Diagnostics | **Eiman Kanjo**<br>Imperial College London |
| 10:30 – 11:00 | Discussion – Embedding control theory in closed loop devices | |
| **11:00 – 11:30** | **Coffee break (Mezzanine level)** | |
| **Session 4: Applications and clinical views** | | |
| 11:30 – 12:00 | Modulating pre-sleep alpha in chronic pain under real life conditions; clinical considerations | **Steve Halpin**<br>Leeds Teaching Hospitals and Leeds Community Healthcare NHS Trusts, and University of Leeds |
| 12:00 – 12:30 | Closed loop deep brain stimulation for Parkinson's disease and movement disorders | **Monty Silverdale**<br>Consultant/University of Manchester |
| 12:30 – 13:00 | Closed loop neural interfaces for improving physical and cognitive functions | **Mahnaz Arvaneh**<br>University of Sheffield |
| **13:00 – 14:00** | **Lunch (Mezzanine level)** | |
| **14:00 – 14:30** | **Road mapping and position paper planning** | |
| 14:30 – 14:45 | Closing comments | **Andrew Sharott**<br>University of Oxford |
| **14:45** | **End of Day 2** | |

# About the Speakers

| Day 1 | |
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| **Alex Casson**<br>  | **Professor Alex Casson** is a specialist in non-invasive bioelectronic interfaces: the design and application of wearable sensors, and skin-conformal flexible sensors, for human body monitoring and data analysis from highly artefact prone naturalistic situations. His ultra low power sensors work is mainly for health and wellness applications, with a strong background in brain interfacing (EEG and transcranial current stimulation) and heart monitoring. Applications focus on both mental health situations including chronic pain, sleep disorders, and autism, and physical health/rehabilitation applications including diabetic foot ulceration, and chronic kidney disease. He has particular interests in closed loop systems: those which are tailored to the individual by personalised manufacturing via printing; and tailored to the individual by adjusting non-invasive stimulation (light, sound, electrical current) using data driven responses/outputs from real-time signal processing. |
| **James Fildes**<br>  | **Professor Fildes** is the founding CEO of Pebble Biotechnology Laboratories, a state-of-the-art surgical facility established to test novel therapies, medical devices, and biomaterials. Pebble replace laboratory animals with next-generation porcine living-organ and human living-blood systems that enable novel, high-risk therapies to be tested, de-risked, and safely accelerated to clinical trials. Pebble's systems are not defined as animal research, negating approvals and reducing preclinical costs. Pebble also has a broad pipeline of innovations related to donor organ preservation and perfusion, and novel medical devices for sepsis and CRS. Prof Fildes is also the Founding Chairman of the Pebble Institute, an independent academic institute that supports tangible, meaningful research that has line-of-sight to patients. |
| **Kavit Amin**<br>  | **Dr Kavit Amin** is an Academic Clinical Lecturer in Plastic & Reconstructive Surgery. He holds a PhD from the University of Manchester where his research focused on optimising ex-vivo perfusion methods to improve limb preservation for transplantation.<br>Building on this, he now utilises this platform to explore advancements in prosthetic and engineered limb technologies. By integrating his clinical experience with his research, he aims to identify solutions that will restore the functional independence of individuals with limb impairment. |

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| **Iwan Roberts**<br>  | **Dr Iwan Roberts** is a Postdoctoral Research Associate in the Department of Clinical Neuroscience at the University of Cambridge. With a multidisciplinary background, Iwan completed an MPhys Physics degree at Durham University followed by a PhD in the EPSRC MRC CDT for Regenerative Medicine at the University of Manchester focussing on tissue engineering of contractile tissues. At the University of Cambridge, Iwan works with Prof Manohar Bance and colleagues on a range of projects regarding cochlear implants. These range from creating 3D printed electrical and mechanical phantoms of the cochlea, fabricating microfluidic cochlea-on-a-chip models for auditory nerve cell culture, finite element computational models of electrode nerve interactions, and various 3D image analysis and characterisation tools. More recently, Iwan has also been developing on-ear wearables for the evaluation of key digital biomarkers from the ear including movement and electrophysiological signals. |
| **Alex Frangi**<br>  | **Professor Alejandro Frangi** FREng graduated in Telecommunications Engineering from the Technical University of Catalonia (Barcelona, 1996) and pursued his PhD in Medicine at the Image Sciences Institute of the University Medical Centre Utrecht University (Utrecht, 2001) on model-based cardiovascular image analysis. He was a visiting researcher at Philips Medical Systems BV, The Netherlands (1998) and Imperial College in London, UK (2000). Professor Frangi holds the Bicentennial Turing Chair of Computational Medicine and RAEng Chair in Emerging Technologies at the University of Manchester. He holds appointments in the Schools of Health Sciences (Division of Informatics, Imaging and Data Sciences) and Engineering (Department of Computer Science). He holds an ERC Advanced Grant and coordinates the InSilicoUK Innovation Network (www.insilicouk.org). |
| **Samit Chakrabarty**<br>  | **Dr Samit Chakrabarty** is a lecturer in neuroscience at the University of Leeds, where he specializes in sensory motor neurophysiology, medical technology, and rehabilitation. His academic journey includes a PhD from the University of Cambridge and postdoctoral research at Columbia University, NYC, and the Spinal Cord Research Centre in Winnipeg, Canada. He has also served as a Visiting Associate Professor at the University of Copenhagen and a Research Associate at Columbia University, NYC.<br>Samit has published extensively, contributing valuable insights into the neurophysiology of movement disorders. He also collaborates with several Startups to develop medical |

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| | technologies, towards translating the research findings into practical applications for patient care. |
| **Leen Jabban**<br>  | **Dr Leen Jabban** is a lecturer in the department of Electronic and Electrical Engineering, and a member of the Centre for Bioengineering & Biomedical Technologies at the University of Bath. Her research interest is in biomedical engineering, focusing on user-centred design, prostheses, and neural stimulation. She has explored user needs and novel nerve stimulation approaches, such as temporal interference stimulation. She has combined computational modelling, instrumentation design, and both human and animal experiments in her work, aiming to enhance prosthesis usability and integration. Recent work includes a focus on using IoT to enable the remote co-create of assistive technologies. |
| **Mafalda Ribeiro**<br>  | **Mafalda Ribeiro** is a PhD student at the Centre for Accountable, Responsible, and Transparent AI (ART-AI) at the University of Bath. She has an MEng in Electrical & Electronic Engineering from the University of Bath, and her current PhD research is focused on ML and optimisation techniques for closing the loop in implantable peripheral nerve interfaces. More specifically, she has carried out large animal studies in different modalities (in-vivo and ex-vivo) and investigated new ML and optimisation techniques to denoise and extract meaningful features from electrical recordings of peripheral nerves. During her PhD, Mafalda also worked at The Technology Partnership (TTP) in R&D and client-facing health tech projects, including developing a low-power ML prototype for implantable cardiac devices. |
| **Maria Petrou**<br>  | **Maria Petrou** is a first-year PhD student in the Department of Electrical and Electronic Engineering at the University of Bath. The aim of her PhD - “Towards a hybrid neuroprosthesis for the restoration of bladder control after spinal cord injury” - is to contribute to developing an implant that can measure bladder pressure in real-time and respond appropriately so that people with spinal cord injury can have improved bladder control. Neuroprostheses can improve bladder control in spinal cord injury patients by extracting bladder pressure from the sacral roots (S1-S3) using ENG neural recordings. Bladder fullness estimation could be achieved through signal processing methods and machine learning algorithms, which recognise patterns between neural firings in the sacral roots and bladder pressure. This could form a closed-loop system by designing an artificial muscle that responds to changes in bladder pressure to control the bladder and thus restore normal bladder function. |

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| **Hadi Heidari**<br>  | **Professor Hadi Heidari** is EPSRC Open Fellow and Professor of Nanoelectronics at the James Watt School of Engineering at the University of Glasgow, United Kingdom. He is the Head of the Electronics and Nanoscale Engineering Division. His Microelectronics Lab (meLAB) conducts pioneering research on integrated micro/nanoelectronics design for medical (wearables and implantables) and industrial (quantum computing and ultrasound systems) applications. Prof Heidari is the CTO and co-founder of Neuranics, a deep-neurotech company building next-generation magnetic sensors for wearable neural interfaces. Prof Heidari's meLAB has contributed to £30M national/international research projects and received over £12M funding from major research councils and funding organizations, including the UKRI (EPSRC and Innovate UK), European Commission, the Royal Society, British Council, Scottish Funding Council, and Royal Society of Edinburgh. Prof Heidari was an IEEE Sensors Council Member-at-Large (2020-21 & 2022-23) and IEEE Circuits and Systems Society Board of Governors (2018-20). He acts as the General Chair of IEEE ICECS 2020 and 2022 in Glasgow, Technical Program Chair of IEEE PRIME'19, and serves on the organising committee of several conferences, including the UK Circuits and Systems Workshop (UKCAS) Conference, IEEE SENSORS'16 and '17, NGCAS'17, BioCAS'18, PRIME'15, ISCAS'23 and '25, and the organiser of several special sessions on the IEEE Conferences. Prof Heidari has authored/co-authored over 280 peer-reviewed publications in top-tier journals or conference proceedings and acts as a reviewer for several journals and conferences. |
| **Day 2** | |
| **Long Zhang**<br>  | **Dr Long Zhang** is a senior lecturer with the Department of Electrical and Electronic Engineering at The University of Manchester. His research mainly focuses on control systems and data-driven methods and their application in human systems, smart renewable energy, robotics and transportation systems. His research has been widely supported by EPSRC, EPSRC IAA, Innovate UK, and industrial partners. He has received over £2.5m research funding as principal investigator or co-investigator. Since 2018, he has served as the director of the MSc program in Advanced Control and Systems Engineering. He is also the founding director of the pioneering industrial-scale wind turbine pitch bearing and blade laboratory, where he has led significant advancements in wind turbine pitch bearing fault detection. More recently, he has extended his focus to |

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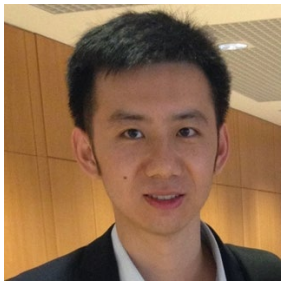
| | applying control theory to understanding brain-mind performance and associated issues. |
| **Hubin Zhao**<br>  | **Dr Hubin Zhao** is an Assistant Professor in Medical Technologies and the Founder and Director of HUB of Intelligent Neuro-engineering (HUBIN, www.hubinresearch.com), at the Aspire Centre for Rehabilitation Engineering and Assistive Technology (acting as one of leading PIs), Division of Surgery and Interventional Science, Faculty of Medical Sciences, UCL. He is also a PI at the Department of Medical Physics and Biomedical Engineering, Faculty of Engineering Science, UCL. Hubin has strong background in Electronic Engineering & Neural Engineering, and his research group is working at the intersection of Advanced Electronics, Artificial Intelligence, Neural Engineering, and Medical Technologies. So far, he has authored more than 60 peer-reviewed publications. His work has also led to several international patents and book chapters. |
| **Eiman Kanjo**<br>  | **Professor Eiman Kanjo** is the Provost's Visiting Professor in Pervasive Sensing and tinyML at the Department of Computing at Imperial College London. She is also a Professor of Pervasive Computing at Nottingham Trent University, leading the Smart Sensing Lab. She has been honoured as one of the Top 50 Women in Engineering by the Women in Engineering Society. She was also one of the academic leads of the Turing University Network, Alan Turing Institute is UK's national institute for data science and artificial intelligence. One of the 24 recipients of the Turing Network Development Awards 2022. She has over 130 publications and she won several grants from various funders, including DCMS, Innovate UK, EPSRC, InnovateUK, SBRI, EU, DSTL, ERDF, MoD, and the Lottery Fund. Prof. Kanjo is dedicated to working closely with charities, local authorities, and industry. She works closely with tinyML Foundation and currently serves on the steering committee for tinyML EMEA, the Research Symposium and Lead TinyML UK along with ARM, she is also a member of the Benchmarking and Dataset working groups. She is also an editor at Data Centric Engineering Journal She joined the Health Data Research UK leadership team as an Associate Director. HDRUK's mission is to improve the quality of health-related data and to drive forward new technologies to equip our frontline clinical staff to deliver excellent care. Previously she worked as a Research fellow at both the University of Cambridge, and the University of Nottingham. |

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| **Steve Halpin**<br>  | **Dr Steve Halpin** is a Senior Clinical Research Fellow and honorary Consultant in Rehabilitation Medicine at the University of Leeds and Leeds Teaching Hospitals and Leeds Community Healthcare NHS Trusts. His current research is in chronic pain and sleep disturbance, neurorehabilitation technologies and multisystem long-term conditions such as long covid. He is interested in how appropriate use of technology can help personalise and expand access to rehabilitation therapies for common conditions which give rise to large burdens of ill health and disability and are inadequately served by existing medical approaches. |
| **Monty Silverdale**<br>  | **Dr Monty Silverdale** is a Consultant Neurologist at the Manchester Centre for Clinical Neurosciences in Salford Royal and a Professor of Neuroscience at University of Manchester. He is a lead Neurologist on the Greater Manchester DBS programme which is one of the largest in Europe. He is a past Chair of the UK Deep Brain Stimulation Network. His research interests include improving Deep Brain Stimulation outcomes using sensing and closed loop technologies. |
| **Mahnaz Arvaneh**<br>  | **Dr Mahnaz Arvaneh** is a Senior Lecturer at the Department of Automatic Control and Systems Engineering (ACSE), University of Sheffield. Her research is centered on the user-centric design of non-invasive closed-loop neural interfaces and their applications in monitoring and enhancing physical and cognitive performance. As the director of the Brain-Computer Interface laboratory, Mahnaz oversees theoretical, experimental, and translational research aimed at developing therapeutic neuro-technologies. She has made significant contributions to the field, including her involvement in the "Royal Society expert perspective report on neural interface technologies" launched in 2019. Mahnaz also serves as an associate editor for Nature's Scientific Reports and IEEE Transactions on Neural Systems and Rehabilitation Engineering (TNSRE). In recognition of her outstanding contributions, she was awarded the title of best associate editor of IEEE TNSRE in 2023. |