CISMA Colloquia in Intelligent Sensing, Measurement and Actuators

The Future of Intelligent Sensing and Measurement 2020

We are delighted to welcome you to the second annual edition of the Future of Intelligent Sensing and Measurement, on the topics of **Biosensors** and **Artificial Intelligence**. Along with the ten great speakers we have invited, we **welcome all graduate students and early career researchers** to attend the event, and to take part by presenting a **poster** showcasing their research. There will be ample time for questions and audience discussion following each presentation.

This event is sponsored by the **Scottish Universities Physics Alliance (SUPA)** and the **Centre for Doctoral Training in Intelligent Sensing and Measurement**, and it is **free for everyone** who wishes to present their work, or learn about the state of art in the exciting fields of biosensors and artificial intelligence.

Date & Time: Tuesday 3rd November 2020
09:00 – 17:00

Venue: Online

Programme:

09:00 – Registration and coffee
09:30 – Welcome to **Session 1 - Biosensors**
09:40 – **Synthetic biology-enabled new generation biosensors for environmental contamination**
Dr Baojun Wang, University of Edinburgh
10:10 – **Acoustic biosensors are also actuators : medical diagnostics at the point of care, from the sample to the answer**
Dr Julien Reboud, University of Glasgow
10:40 – Coffee break
11:10 – **Sensor development for detection of antimicrobial resistance and co-selectors in water**
Dr Helen Bridle, Heriot Watt University
11:40 – **Development of new biosensors for infectious disease**
Dr Damion Corrigan, University of Strathclyde
12:10 – **Lab-on-chip devices for the rapid diagnostics, therapeutic and drug efficacy monitoring**
Dr Samadhan Patil, University of York

12:40 – Lunch break; Posters in breakout rooms

13:30 – Welcome to **Session 2 – Artificial Intelligence**
13:40 – **Applications of microfluidics in biomedical devices**
Professor James McLaughlin, Ulster University
14:10 – **From wearable sensing to human-AI augmentation models: challenges and opportunities**
Dr Fani Deligianni, University of Glasgow
14:40 – **Seven simple steps to simplify AI**
Mr Sherin Mathew, Founder of AI Tech North, Microsoft GBS UK
15:10 – Refreshment break
15:40 – **Deep learning at the edge**
Professor Amos Storkey, University of Edinburgh
16:10 – **Beyond what the human eye sees: AI in medical imaging**
Ms Ana Jiménez Pastor, QUIBIM
16:40 – Prizes and farewell
17:00 – Close

Registration at:
www.cisma-colloquia.com

This event has been fully funded by the Scottish Universities Physics Alliance (https://www.supa.ac.uk/) and the the EPSRC Centre for Doctoral Training in Intelligent Sensing and Measurement (https://www.cdt-ism.org/) In collaboration with: Machine Learning in Science, University of Edinburgh IEEE, AI Tech North and EPSRC. Follow us on Twitter @CISMA_Colloquia

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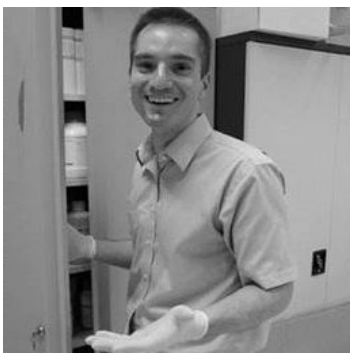
Synthetic biology-enabled new generation biosensors for environmental contamination
Dr Baojun Wang, University of Edinburgh

Cell-based biosensors have great potential to detect various toxic and pathogenic contaminants in aqueous environments. Here, we investigated a modular, cascaded signal amplifying methodology to address this issue. We first tuned intracellular receptor densities of the sensory module to increase sensitivity, and then engineered ultrasensitive activator-based multi-layered transcriptional amplifiers to sequentially amplify the transduced sensor signal and boost output expression level. We demonstrated these strategies by engineering ultrasensitive bacterial cell-based sensors for arsenic and mercury. We next developed an encapsulated microbial sensor cell array for low-cost, portable and precise field monitoring, where the analyte concentration can be readily visualized via displaying an easy-to-interpret volume bar-like pattern.



Acoustic biosensors are also actuators : medical diagnostics at the point of care, from the sample to the answer
Dr Julien Reboud, University of Glasgow

Acoustic sensing is a cornerstone for many real-world applications, from validating the fatigue of complex off-shore structures to checking on pregnancies. At high ultrasonic frequencies, these sensors have also been used to detect molecular biomarkers at very high sensitivities for example to identify viruses and other pathogens, with the added advantage of not requiring any labelling chemistries. However, performance in real, complex biological sensors is often hindered by the presence of other molecules or components (such as blood cells) that need to be removed using complex processing techniques in well-resourced laboratories. In this talk, we will explore how acoustic excitation can be used to perform these sample preparation steps on integrated, low-cost, battery-operated systems, at the point-of-care by harnessing fluidic actuation using acoustics.

Sensor development for detection of antimicrobial resistance and co-selectors in water
Dr Helen Bridle, Heriot-Watt University

Dr Bridle is leading a NERC-DST funded project to develop sensors for monitoring of antimicrobial resistance (AMR) in the water environment. Existing efforts for monitoring on AMR in aquatic environments are limited, not only in India but across the globe, owing to lack of robust, economic, and easy to deploy detection tools. This has resulted in incomplete understanding of AMR and targeted case studies, with a focus on the proliferation of AMR upon exposure to heavy metals, antimicrobials and additives such as triclosan, are desperately needed. Our project has developed a range of sensors for heavy metals and antimicrobials, with work in progress on an electrochemical based system to detect AMR genes.

Development of new biosensors for infectious disease
Dr Damion Corrigan, University of Strathclyde

COVID-19 and antimicrobial resistance (AMR) present two hugely significant global healthcare challenges. An important aspect of meeting these challenges is diagnostic testing. This talk will describe two new biosensor technologies, first, a rapid antibiotic susceptibility test (AST) which can rapidly determine the best antibiotic with which to treat a bacterial infection and second a simple biosensor capable of detecting the SARS-CoV-2 virus (causative agent of COVID-19) from complex samples. Both biosensors have been designed and validated with high volume production and ease of use in mind, with the aim that both can transition from academic projects to implementable systems and manufactured at scale in order to meet the complex diagnostic challenges posed by AMR and COVID-19.

Lab-on-chip devices for the rapid diagnostics, therapeutic and drug efficacy monitoring
Dr Samadhan Patil, University of York

Sensors with higher transduction efficiency and with the appropriate transduction mechanism are desirable for the bio-medical applications such as rapid diagnostics and therapeutics monitoring. The capabilities of these sensors with features such as the ease of use, requirement of less peripheral instrumentation and adaptability to plug and play determine their translation in the point-of-care diagnostic devices. In this talk; I will take you through my work on the development and use of CMOS based photodiodes, Micro-electro mechanical sensors (MEMS) and spintronic devices (spin valve and tunnel junctions) for the biomedical applications such as for the detection of the biomarkers infectious and non-infectious diseases. Work on the integration of MEMS with the spintronic devices (such as spin-valves or tunnel junctions) for the detection of an ultra-low magnetic field (~pico-Tesla) will also be presented.

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Applications of microfluidics in biomedical devices

Professor James McLaughlin, Ulster University

This talk will focus on reviewing our capacity and expertise in the area of Healthcare Sensor Systems at NIBEC in the area of clinical and home-based monitoring. In particular, the talk will demonstrate and detail the importance of operating characteristics such as high sensitivity and high specificity sensor specifications when integrated into wearable and mobile patient monitoring, rapid point of care diagnostics and the need to design integrated robust systems with low-false positives/negatives. The talk will also highlight areas where we are using nanotechnology such as CNT/graphene electrodes, nano-colloid gold in lateral flow systems for sensing and nano Si for efficient drug delivery. In particular we will refer to novel microfluidic and integrated smart needle solutions that when combined with integrated IOT based optical readers connected to cloud platforms present a complete diagnostic solution for self-monitoring via derived AI based algorithms.

From wearable sensing to human-AI augmentation models: challenges and opportunities

Dr Fani Deligianni, University of Glasgow

Current progress in artificial intelligence (AI) paves the way towards intelligent systems that enable automation with unprecedent precision in tasks such as computer vision and action planning. Adapting these models in critical applications both in industry and healthcare is still under debate due to the lack of model transparency and methods to reliably quantify how much we can trust them in unforeseen circumstances. There is also a risk that with increased automation, humans become just observers and they are not actively engaged in the loop. In this talk, Deligianni will highlight current challenges and opportunities in human-machine collaborative frameworks and present paradigms on how AI technology along with wearable/ambient sensing can improve decision making processes.

Seven simple steps to simplify AI

Sherin Mathew, AI Tech North, Microsoft GBS UK

A session to make AI Simple and accessible to all. An executive thinking and thought-provoking session on how to get started with AI. Demystifying the AI myths and addressing the key capabilities, sharing the secret ingredients in defining a successful AI strategy for yourself or for your business. In this session, Sherin shares a simple framework that allows you to define and deliver a successful AI strategy by simplifying the complex AI value chain in 7 simple steps.

Deep learning at the edge

Professor Amos Storkey, University of Edinburgh

In the deployment of modern small sensor systems, there is often a need do sophisticated analysis of the data. Traditionally, in these settings, data is ported to the cloud for analysis. However there are many settings where this is problematic - bandwidth may be limited, or latency too high, and on-device decisions might need to be made. Ideally we would like to be able to do analysis on device if we so choose. In this talk I will discuss a number of approaches for tackling the issue of improving the efficiency and robustness of deep learning methods for the deployment in edge devices.

Beyond what the human eye sees: AI in medical imaging

Ms Ana Jiménez Pastor, QUIBIM

Today a radiologist reports dozens of medical images daily using his high knowledge and experience. But what about all that information that is hidden behind the pixels of a radiological image? Using advanced mathematical modeling techniques and artificial intelligence we can extract from the images large amounts of data that give radiologists added value to the images themselves and, for example, we can go from saying that a patient suffers from moderate brain atrophy to saying that he or she has suffered a loss of 5% of brain volume, adding to the radiologist's qualitative report, specific quantitative values of the patient and moving forward on the road to personalized precision medicine.

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