Aston University
BIRMINGHAM UK

College of Engineering and Physical Sciences

Call for Engineering and Physical Sciences DTP PhD Applicants – Academic Year 2022 - 23

Deadline for applications: 31st January 2022

List of 2022-23 Projects

2022-2023_001 – Compact THz Systems for Biomedical Applications

Supervisor Professor Edik Rafailov (Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Dr Natalia Bazieva (Aston Institute of Photonic Technologies - AiPT)

Area of Research: THz sources development and biophotonics application.

Project Summary Aim and Objectives The development of compact turn-key THz diagnostic systems to be used by non-physicists is of high-demand. THz are non-destructive and non-ionising radiation and THz technology, despite being relatively young (in comparison with microwave and optical neighbours) has been implemented and/or is predicted to be implemented in numerous applications within various scientific and non-scientific areas. Application of such systems for biomedical spectroscopic diagnostics and treatment, creation of spectral database and thorough spectroscopic studies involving the joint team of physicists, biophysicists and medical doctors is of great importance.
Efficient THz generation and detection techniques are being studied in many research institutions globally. Much less focus is given to THz biomedical applications. This is because, despite more than 30 years of development, state of the art THz technologies are still complex to use and not available for non-specialists. The successful launch of ultra-compact room-temperature operating THz transmitters resulted from our previous EPSRC projects and significantly broadens accessibility to turn-key compact THz setups. Higher generated powers will allow faster data acquisition and smoother operation. Strong beam directionality and broad tenability of antennae will be accompanied by the higher powers allowed by QD based structures and QCLs, the compactness allowed by semiconductor pump lasers, and the alignment-free construction allowed by intra-cavity operation.

Knowledge and skills required in applicant:
The successful applicant should have a Master degree in physics/engineering and some research experience in Laser and THz generation/registration physics.

2022-2023_002 – Low Footprint Computing with Light

Supervisor: Dr Auro Michele Perego (Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Dr Morteza Kamalian Kopae (Aston Institute of Photonic Technologies - AiPT)

Area of Research: Photonics, Computer Science, Machine Learning, Reservoir Computing, Nonlinear Optical Resonators

Project Summary, Aim and Objectives: The increasing use of Machine Learning and Artificial Intelligence (AI) techniques to solve everyday life problems has led to a significant increase in the demand for computational power. So far this demand has been met by making computing elements more compact and small. This size reduction process is anticipated to hit a fundamental limit imposed by the physics of microchips fabrication and by the conventional approach to computing (Von-Neumann architectures).

Moreover continuing along the current path of scaling up computational power will dramatically increase energy footprint leading to a power hungry AI.
One of the promising solutions to both the dimension and energy footprint problem is the so-called *optical reservoir computer* (ORC). ORC exploits the rich nonlinear dynamics of light waves propagating inside optical circuits, which is crucial for effective and fast data manipulation. These circuits can be realised by means of optical microresonators with sub mm size and potential for chip integration. ORC can perform computations with reduced training time and less computational complexity compared to conventional platforms.
The PhD candidate will become familiar with theoretical and numerical simulations tools for investigating the computational power of different photonic platforms and configurations. They will design an optimum ORC computational platform taking into account realistic scenarios and constrains.
The research will be conducted in the highly stimulating and multidisciplinary environment offered by the Aston Institute of Photonic Technologies, with available academic and scientific support from experts in the fields of Machine Learning and nonlinear photonics.
This research topic develops at the interface between photonic engineering and computer science, and it is at the forefront of current industrial research effort, led by major tech companies, towards developing a green AI and the computers of the future.

Knowledge and skills required in applicant:
The desired candidate will possess a degree in Engineering, Physics or Mathematics, and have basic programming skills, analytic mindset and the motivation and enthusiasm to work at the boundaries between different disciplines like data science and nonlinear optics. A good background in physics and modelling of photonic systems is preferable.

2022-2023_003 – Electro-Synthesis of Metal-Organic Framework (MOF) Based Energy Storage Devices

Supervisor: Dr Stephen David Worrall (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Vesna Najdanovic (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)

Area of Research: Nanomaterials, energy storage and pollutant capture

Project Summary, Aim and Objectives: Climate emergencies are being declared across the globe as carbon dioxide levels rise and we continue to pollute our environment. Renewable sources are playing a growing role in electricity generation, with 20% growth predicted in the next three years, however compared to fossil fuels they are intermittent. As times of peak generation do not coincide with peak demand the ability to store this renewably generated energy in a way that can be released on demand is absolutely essential.

Supercapacitors are a type of device that can rapidly release their stored energy, with the amount of energy stored being proportional to the surface area of their electrically conductive active material. Metal-organic frameworks (MOFs) are a type of highly modifiable, porous nanomaterial with incredibly high surface areas that would make attractive active materials; however, they are usually electrical insulators. Promising recent research has shown that it is possible to make MOFs that are electrically conductive, but this work is still in its infancy. Additionally, MOFs have shown great promise for the

adsorption and degradation of waterborne pollutants, meaning that these materials could be a "swiss army knife" in our fight for a cleaner, greener world.

In this project:
1) Novel MOF materials with superior electrical conductivity will be synthesised using electrochemical techniques.
2) Different electrochemical techniques will be investigated to create superior coatings, in terms of chemical and operational stability, for use in devices.
3) Utilising the materials obtained from the first objective and the knowledge gained from the second, devices for charge storage and pollutant capture/degradation will be fabricated.
4) The performance of the devices (e.g. charge storage capacity, operational stability, rate of pollutant capture/degradation) will be assessed and compared to the best performing devices in the literature

Knowledge and skills required in applicant:
A good background knowledge in Chemistry/Materials Science, as evidenced by a Bachelor's or Master's degree (at a minimum of Upper Second class honours) in a relevant subject. Knowledge of inorganic materials and electrochemistry particularly desirable. Basic skills in synthetic and analytical chemistry required.

2022-2023_004 - Catalyst Development for the Conversion of Bio-Alcohols to Aviation Fuels

Supervisor: Dr Qingchun Yuan (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Professor Tony Bridgwater (Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Daniel J. Nowakowski (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Alberto Almena-Ruiz (Energy and Bioproducts Research Institute - EBRI)

Area of Research: Catalyst development (synthesis, characterisation and testing), nanomaterials

Project Summary, Aim and Objectives: This project aims to develop catalysts that directly convert bio-alcohols into sustainable synthetic aviation fuels to aid the decarbonisation of aviation industry.
Bio-aviation fuels derived from plant oils and animal fats have been more and more extensively used by aviation companies to reduce their carbon emission. With the Carbon Budget Order 2021, the UK government legally bound its commitment to reduce GHG emissions by 78% by 2035 and achieve Net-Zero by 2050. This requires a large amount of aviation fuels from sustainable renewable resources in the foreseeable future. Synthesising sustainable aviation fuels from biomass of agriculture and forest wastes can be an applicable solution if the technology itself can be economically sustainable. So far, the production route via alcohols is not well studied yet, especially the catalyst for the conversion of alcohols to branched or cyclic hydrocarbons with a carbon number of around 12.
This project will focus on the catalyst development to go beyond the one developed so far: ZSM-5. New catalysts will be developed from metal organic frameworks (MOFs) to overcome the limitations of ZSM-5. The research objectives include selecting suitable MOFs to provide catalytic sites and desired pore structures larger than that of ZSM-5, modifying them into catalysts and testing the conversion of bio-alcohols to hydrocarbons. Full characterisation equipment and testing reactors are available to support optimisation and mechanism study.

Knowledge and skills required in applicant:
Essential: A first-class or upper second-class honours degree in chemical engineering, chemistry or materials. Desired: Knowledge in nanomaterials synthesis, characterisation and catalyst testing.

2022-2023_005 - Design and Synthesis of Metal-Based Catalysts for Carbon Dioxide/Epoxide Co-polymerisation to Yield Biodegradable Polymers

Supervisor: Dr Petra Van Koningsbruggen (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute of Materials Research)
Assoc. Supervisor: Dr Qingchun Yuan (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)

Area of Research: Design and synthesis of metal based – catalysts for carbon dioxide / epoxide co polymerisation to yield biogradable polymers

Project Summary, Aim and Objectives: This project focuses on developing well-defined Double Metal Cyanide (DMC) catalysts for production of biodegradable polymers obtained from carbon dioxide and epoxides (e.g. propylene oxide (PO) or cyclohexene oxide (CHO)). The project's need and urgency is driven by 2 major global environmental problems that threaten the survival and health of all creatures on Earth: (1) titanic carbon dioxide emissions and (2) hard-degradable plastics' waste pollution from human activities.
The project objectives include the controlled synthesis and characterisation of DMCs, the evaluation of catalyst performance in carbon dioxide/epoxide polymerisation, as well as characterisation of the produced polypropylenecarbonates (PPC) or polycyclohexenecarbonates, together with a techno-economic analysis to explore the carbon dioxide utilisation potential and sustainability. Achieving these objectives will contribute towards reaching the aim of accelerating industrialisation of this polymerisation process, which will benefit the reduction of carbon dioxide emissions and decrease plastics pollution.

Knowledge and skills required in applicant:
Candidates are expected to have a solid background in inorganic chemistry, organic polymer chemistry and/or chemical engineering, and a strong interest in being trained as a multidisciplinary researcher. Applicants should hold or expect a first class or upper second-class degree in Chemistry or Chemical Engineering.

2022-2023_006 - An Investigation of Decarbonising Agents as a Low-Carbon Technology in the Transition to Transport Electrification

Supervisor: Dr Jose Ricardo Sodre (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Tabbi Awotwe (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Abul Kalam Hossain (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)

Area of Research: Sustainable Energy and Transport

Project Summary, Aim and Objectives: The aim of this project is to investigate the impacts of decarbonising agents on the reduction of fuel consumption, carbon, oxides of nitrogen (NOx) and particulate matter emissions. Two decarbonising agents of different manufacturers will be chemically characterised and blended at specific concentrations to the fuel tank of a commercial vehicle and submitted to road tests. The vehicle will be equipped with high-specification, research and certification grade on-board gas analysers to measure the exhaust concentrations of total hydrocarbons (THC), nitric oxide (NO), NOx, nitrogen dioxide (NO2), carbon monoxide (CO), carbon dioxide (CO2), and particulate number (PN). The vehicle will be operated under the real driving emissions (RDE) test schedule. The results will be evaluated based on the decarbonising agent physical-chemical properties and chemical composition. The project outcomes are expected to show the magnitude of the impacts of decarbonising agents on fuel consumption and emissions reduction and demonstrate them as feasible low-carbon technologies to be adopted in the transition to electric vehicles.

Knowledge and skills required in applicant:
The candidate should have a strong background on Thermodynamics, Combustion and Internal Combustion Engines. It is highly desirable previous experience in engine test and emission measurements. Skills on engine control, fuel chemistry and fuel additives will also be appreciated.

2022-2023_007 - Mid Infrared Fibre Laser and Device Technologies for Biomedical Sensing and Imaging

Supervisor: Dr Kaiming Zhou – (School of Infrastructure and Sustainable Engineering; Electrical and Electronic Engineering Department / Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Dr Laura Leslie (School of Engineering and Applied Science; Engineering and Technology / Aston Institute of Urban Technology and the Environment – ASTUTE / Aston Institute of Materials Research
Assoc. Supervisor: Professor Sergei Turitsyn (Aston Institute of Photonic Technologies - AiPT)

Area of Research: Photonics, mid infrared laser spectroscopy, Laser microfabrication, biomedical sensor and sensing

Project Summary, Aim and Objectives: Taking advantages of strong fundamental finger print absorptions of many important biomolecules, such as proteins, lipids, amides, carbon hydrate and various gases , mid Infrared (Mid-IR) spectroscopy has been widely used in the fields of healthcare, biomedicine, environment, food , pharmaceuticals , oil and petrol. However, tradition Mid-IR spectroscopies suffer from long measurement time , unsatisfactory detection of limit , large footprint size and thus their capabilities are limited for on-line applications which require fast, highly sensitive and accurate measurement. Newly emerged Mid-IR photonic devices, fibre laser and dual frequency combs will revolutionise this technology empowering a list of new technologies and applications including Mid-IR microscope for rich chemical and structural information of biological samples like coronavirus and Mid-IR sensing and hyperspectral imaging for cancer cell screening.

The student will be trained through three key research objectives:
(i) Development of laser microfabrication technology for Mid-IR photonic devices.
(ii) Development of novel Mid-IR fibre laser.
(iii) Application of the developed laser for sensing of bio-materials and hyperspectral imaging of bio-samples, with a focus on biomedical applications.

The success of the research project and training will be ensured by: (i) supportive environment of the two research institutes with the state-of-the-art facilities available for this cutting-edge research (including the ultrafast laser microfabrication system, the Mid-IR characterisation set-up, the Particle Image Velocimetry and many others); (ii) general technical support from the institutes' experienced staff with expertise in laser technology, Mid-IR techniques and biomedical sensing and imaging, and (iii) dedicated support from two co-supervisors and senior mentor with complementary skills, including fabrication of photonic devices, fundamental theoretical modelling and biomedical applications.

Knowledge and skills required in applicant:
The successful applicant should have a first class or upper second class honours degree in physics, electronic engineering or an MSc in a subject related to optics, photonics, or other relevant subjects. Preferred skill requirements include knowledge/experience of fibre optics and lasers.

We would particularly like to encourage applications from women seeking to progress their academic careers. Aston University is committed to the principles of the Athena SWAN Charter, recognised recently by a prestigious Silver Award to EAS, and we pride ourselves on our vibrant, friendly and supportive working environment and family atmosphere.

2022-2023_008 - Optimising Humidity and Thermal Management for Improved Performance and Efficiency of Proton Exchange Membrane Fuel Cells

Supervisor: Dr Abed Alaswad (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Energy and Bioproducts Research Institute - EBRI / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Jose Ricardo Sodre (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department, Aston Institute of Urban Technology and the Environment – ASTUTE / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Tabbi Awotwe (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Sustainable Energy and Transport, Fuel cells

Project Summary, Aim and Objectives: Proton exchange membrane (PEM) fuel cells are electro-chemical energy conversion systems with expanding and can operate in a variety of applications in transport, energy storage system (ESS) to support the use of intermittent renewable energy resources, and portable devices. The performance and conversion efficiency of a PEM fuel cell are largely affected by the membrane temperature and water content, as these parameters directly influence the membrane ionic conductivity. Hence, this research aims to optimise the fuel cell thermal and humidity management by fulfilling the following objectives:

1. Develop and experimentally validate electrochemical and thermal models to predict the performance and efficiency metrics in both the transient and steady state fuel cell operation modes
2. Analyse the effects of temperature and humidity on the performance and efficiency of a PEM fuel cell
3. Using multi-objective optimisation, determine the optimal conditions to maximise the conversion efficiency and deal with performance issues

Knowledge and skills required in applicant:
Bachelor degree in Engineering (Mechanical, Chemical, Electrical/Electronic or similar)
Numerical modelling skills, preferably in computational fluid dynamics (CFD

2022-2023_009 - Biopolymer Production from Renewable Biomass

Supervisor: Dr Paula Helena Blanco Sanchez (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI / Aston Institute for Materials Research)
Assoc. Supervisor: Dr Matthew Derry (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute of Urban Technology and the Environment – ASTUTE / Aston Institute for Materials Research)
Assoc. Supervisor: Professor Paul Topham (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute of Urban Technology and the Environment – ASTUTE / Aston Institute for Materials Research)

Area of Research: Chemical Engineering, Chemistry, Computer Sciences

Project Summary, Aim and Objectives: Around 1.7 million tonnes of plastics are produced in the UK each year, but only ~1% of these products are made from renewable resources, while the majority still relies on fossil fuels conversion. This clearly needs to change if we are to meet the UK's 2050 net-zero target. The structural diversity of biomass resources makes them good candidates for the synthesis of renewable monomers and polymers substituting in this way the need for petrochemical resources.
This project will explore and identify a sustainable pathway for biomass waste conversion into functional molecules to obtain bio-based and biodegradable polymers. For example, sugar derivable building block chemicals will be obtained and transformed into new families of commercially relevant molecules such as levulinic acid and hydroxymethyl furfural (HMF).
The project will use a novel approach combining experimental and artificial intelligence tools to identify and optimise a suitable pathway. The ultimate goal will be to obtain renewable biopolymers with excellent thermomechanical properties and with potential scalability to replace fossil fuel-derived polymers.

Knowledge and skills required in applicant: The applicants should:
Possess a good honours degree (1st Class or 2:1 minimum) in chemical engineering or chemistry.
Demonstrable experience working in a laboratory environment.
A strong interest in developing laboratory methodologies and formulating engineering solutions to environmental problems.
Willingness to learn how to operate experimental and analytical equipment.

2022-2023_010 - Dual Hydrogen Refuelling/Electric Charging Station (DHREC) Fuelled by Biofuels: A Smart Energy System for Net-Zero Targets

Supervisor: Dr Amirpiran Amiri (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department, Energy & Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Zhentao Wu (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department, Energy & Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Jose Ricardo Sodre (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Energy & Bioproducts Research Institute - EBRI / Aston Institute of Urban Technology and the Environment – ASTUTE)

Area of Research: Hydrogen, Membrane, Fuel cell, Biofuels, Carbon capture

Project Summary, Aim and Objectives: If you want to play an important role in rapidly growing hydrogen economy, this is the project for you. The key to a successful future for hydrogen is the development of further knowledge in this subject, attending the industry and business needs. Thus, the objective of this project is to support the design of the next generation of smart fuel stations minimising the electricity grid dependency while maintaining the UK's 284,000 km gas grid infrastructure for a key role in the hydrogen economy. To this end, it will design and techno-economically prove an electricity grid-independent dual H2 refuelling/electric charging station (DHRECS) system. We will develop a model for the system and its balance-of-plant to demonstrate its efficiency, carbon footprint and fuel flexibility. In the proposed DHRECS system, both electricity and hydrogen will be produced on-site. High quality heat will be achieved and non-fossil CO2 will be separated through a technically simple and economically efficient process.

As a PhD candidate, you will be working with internationally known multidisciplinary researchers accessing state-of-the-art research facilities at the Energy and Bioproducts Research institute (EBRI) of Aston University. Moreover, you will work closely with the Hydrogen and Fuel Cell research centre at the University of Birmingham. All of these provide you with a unique opportunity for training and research in very new and highly demanded research fields including clean fuels, decarbonisation, hydrogen, and fuel cell technologies. This PhD will equip you with the applied skills to deploy theoretical and practical tools for developing next generation clean technologies to save the environment while supporting the economy growth.

Knowledge and skills required in applicant:
MEng/BEng in Chemical/Mechanical Engineering,
Experience and expertise relevant to process computing and lab research
Biofuels and fuel cell knowledge is desirable

2022-2023_011 - BIOPOLY – Single BIOmolecule Detection Via an ELISA Sandwich Assay Through the Realisation of Novel Optical POLYmer Biosensors for a Low Cost Rapid Field Deployable Diagnostic Instrument

Supervisor: Dr Daniel Hill (Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Dr Kaiming Zhou (School of Infrastructure and Sustainable Engineering; Electrical and Electronic Engineering Department, Aston Institute of Photonic Technologies – AiPT)
Assoc. Supervisor: Professor David Webb (School of Infrastructure and Sustainable Engineering; Electrical and Electronic Engineering Department / Aston Institute of Urban Technology and the Environment – ASTUTE / Aston Institute of Photonic Technologies - AiPT)

Area of Research: Optical biosensing

Project Summary, Aim and Objectives: In collaboration with colleagues in EBRI (Dr Alfred Fernández-Castané), LHS (Prof. Anna Hine) and EPS (Dr Thomas Thatapudi) leading academic and industrial collaborators outside of Aston it is proposed to use a novel detection scheme that will actually *capitalize* on the high thermal sensitivity of polymers, which for many applications is problematic, to eliminate for the first time all of their inherent low-frequency (DC) related noise and drift issues in a polymer waveguide based biosensor. So much so that it will result in three beyond state of the art achievements:
(1) ***Polymer photonic biosensing*** - in LoD and selectivity.

(2) ***Photonic biosensing*** – in rapid, sensitive and selective detection from small sample volumes at low cost.
(3) ***Point of Care (PoC) Immunodetection*** – its six unique selling points (USP) will be equal or better than the state of art in PoC immunodetection, where detection of small number of pathogens (bacteria and viruses) normally requires slow incubation processes, providing an alternative to the Gold Standards of immunochemistry or PCR (Polymerase chain reaction).

The project has three principle objectives.
Prime objective (1): Develop the first ever polymer waveguide based biosensor with a low limit of detection (LoD), for few, and potentially single small particle (e.g. peptides, proteins, antibodies and hormones) detection, using a highly promising and novel concept.
Secondary objective (2): Demonstrate beyond state of art photonic biosensing for the Unique Selling Points of portability/field deployable-ness, cost, sensitivity, selectivity, time to result and multiplexing. These are enabled due to both the sensing mechanism itself and because it enables the use of polymer photonic structures and therefore a low cost visible light reader and low cost/large area Lab on Chip cartridges/chips with a very large effective sensing area and thus single particle detection via a sandwich assay.
Prime objective (2): Provide the student with the multidisciplinary technical and complementary skills (managerial, entrepreneurial, communications) she/he requires for a successful scientific career, in academia or industry.

Knowledge and skills required in applicant:
Essential: ***Education and qualifications*** - BEng or BSc in Electrical and Electronic Engineering, Optical Engineering, Photonics, Physics, or equivalent. ***Experience*** – Practical experience in developing and utilising optical setups, General laboratory skills, data taking and analysis. ***Aptitude and skills*** - Creative problem solving skills. Excellent English language communication skills to relay work in spoken and written media. Ability to write reports and contribute to deliverables.
Desirable: ***Education and qualifications*** - Master of Science degree in Electrical and Electronic Engineering, Optical Engineering, Photonics, Physics, or equivalent. ***Experience*** – Experience in COMSOL/RSoft/Lumerical, LabView, photonics, microfabrication.

2022-2023_012 - Nanomaterials for Biocompatible Field-Effect Transistors and Microelectrode Arrays for Advanced Applications

Supervisor: Dr Petro Lutsyk (School of Digital Engineering; Electrical and Electronic Engineering Department, Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Dr Alex Rozhin (School of Digital Engineering; Electrical and Electronic Engineering Department, Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Dr Stuart Greenhill (College of Health and Life Sciences / Aston Institute of Health and Neurodevelopment)

Areas of Research: Nanoscience, field-effect transistors, microelectrode arrays, biocompatible nanoelectronics

Project Summary, Aim and Objectives: The proposed studentship focuses on nanoelectronics – the use of nanotechnology in electronics - an exciting & growing avenue due to recent achievements in nanoscience & instrumentation. Nanomaterials are superior candidates for future electronics with low energy consumption, mechanical flexibility, & biocompatibility enabling ground-breaking practical applications, e.g. wearable healthcare devices, smart packaging, biocompatible electronics, etc.

However, to translate this knowledge into real-world applications, the performance of such devices must be optimised.
This studentship is aiming to study new experimental procedures for nanomaterials processing, design & fabrication of novel nanoelectronic devices, such as field-effect transistors & microelectrode arrays, targeting advanced neuroscience & other applications.
The first research objective is to establish a novel experimental basis for solution-processing of semiconductor nanomaterials (such as carbon nanotubes and so on) for field-effect transistors, which could be a key to enable real-life application of biocompatible nanocarbon electronics.
The second objective is to develop a protocol of nanofabrication of biocompatible microelectrode arrays for brain studies, which have a disruptive potential to give world-first insights into the pathology of epilepsy and other brain diseases.
The proposed project focused on research and development of these techniques at the interface of nanoscience, electronics, photonic engineering, & neuroscience has the potential to lead to high-impact publications and meaningful IP, via the creation of cutting-edge nanomaterial electronics for measuring the electrical activity of brain networks.
Knowledge and skills required in applicant:
The successful applicant should have a first-class or upper second-class honours degree or equivalent qualification in Physics, Engineering, Nanoscience, or similar. Preferred skill requirements include knowledge/experience of nanomaterials processing, experimental characterisation of liquid/solid samples by electrical measurements, and optical spectroscopy techniques.

2022-2023_013 - Sensors-Based Deterioration Monitoring of Ageing Railway Bridges

Supervisor: Dr Haris Alexakis (School of Infrastructure and Sustainable Engineering; Civil Engineering Department / Aston Institute of Urban Technology and the Environment – ASTUTE)
Assoc. Supervisor: Dr Kaiming Zhou (School of Infrastructure and Sustainable Engineering; Electrical and Electronic Engineering Department, Aston Institute of Photonic Technologies - AiPT)

Area of Research: Civil Structural Health Monitoring

Project Summary, Aim and Objectives: Rail infrastructure deteriorates with time due to material fatigue, overloading, ground movement and environmental effects. This might affect the serviceability and structural integrity of rail assets, such as bridges, causing major socio-economic disruptions and occasionally life loss. Ageing masonry bridges comprise around the 50% of the UK and European rail stock and their structural assessment is particularly challenging. Traditional inspection practises and fragmented monitoring appear unable or impractical to ensure adequate maintenance on a national scale. Digitisation of civil infrastructure networks emerges today as an essential next step to address this challenge, offering opportunities to enhance our understanding of the structural deterioration mechanisms involved, and hence supporting decision-making for the maintenance of railway networks.

This PhD research will explore the benefits of combining advanced sensing technologies with data analytics to enable automated civil asset management tools for resilient infrastructure, focusing on ageing railway bridges. The student will work on the processing and interpretation of field monitoring and lab tests data from two ongoing deteriorating bridge monitoring projects. Data science techniques will be applied, combining information from fibre optic strain and temperature sensors, acoustic emission sensors and high-sensitivity accelerometers. The analysis will contribute towards the development of early-warning, sensors-based, deterioration monitoring systems that will integrate machine learning, cloud data management and statistics. The student will benefit from the close

collaboration with researchers from ASTUTE and AiPT at Aston University, the University of Cambridge, the University of California, Berkeley and engineers from Network Rail.

This PhD research combines elements from civil engineering, data science, systems engineering, electronics and photonics. Applications from students with background or aspirations in any of these areas and with interest to develop their digital abilities are welcome to apply. Tailored training on Data Analytics and AI shall be provided.

Knowledge and skills required in applicant:
Essential – BSc in civil/structural engineering, data or computer science, mathematics or statistics, electrical engineering, mechanical engineering, photonics, information and communications technology, or other relevant area
Essential – Experience in coding, data processing
Desirable – MSc or industry experience on data science or relevant area
Desirable – MSc or industry experience on sensing technologies (photonics or electronics)
Desirable – Experience in signal processing, pattern recognition techniques, statistics, neural networks, wavelets, cloud programming
Desirable – Experience in structural health monitoring or non-destructive testing
Optional – Experience in structural lab testing and structural analysis

2022-2023_014 - Antimicrobial Polymer/Bioactive Glass Nanofibers for Chronic Wound Management

Supervisor: Dr Eirini Theodosiou (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department)
Assoc. Supervisor: Richard Martin (School of Digital Engineering; Electrical and Electronic Engineering Department / Aston Institute for Materials Research)
Assoc. Supervisor: Dr Tony Worthington (College of Health and Life Sciences, School of Biosciences / Biosciences Research Group)

Area of Research: Antimicrobial Resistance, Biomaterials, Healthcare Engineering, Tissue Engineering, Chronic wound management

Project Summary, Aim and Objectives: Chronic wounds, such as pressure ulcers, venous ulcers and diabetic foot ulcers, affect a large proportion of the world population, with an estimated 5.7 million patients in the US alone. This silent epidemic poses a major burden to healthcare systems, with annual costs for treatment far in excess of 20 billion USD. These open wounds are often contaminated with different types of microorganisms which are difficult to treat, and occasionally can even lead to amputation. For example, approximately half of the patients with diabetic ulcers develop an infection, with Staphylococcus aureus being the most common infecting organism and 46% of these isolates being methicillin-resistant (MRSA).
Infected surface wounds that ulcerate are difficult to treat. Widespread and prolonged use of antibiotics in the treatment of these ulcers contributes towards antimicrobial resistance, and a preventative strategy that reduces/eliminates infections, would clearly be of great benefit. Current research in wound management aims to create 'smart' or 'bioactive' materials through the incorporation of therapeutic and/or antimicrobial agents, in order to fulfil multiple parts of the wound healing process.
In this project, we plan to develop novel, bioresorbable, wound dressings containing antimicrobial agents with extended release characteristics, to address the issues associated with chronic wound treatment. Polymer-based non-woven mats will act as scaffolds to support and aid the delivery of bioactive glass

containing antimicrobial ions. The latter will provide the antimicrobial properties necessary for infection prevention, whereas the former will offer the controllable porosity, and high surface area-to-volume ratio, to allow for cell proliferation, moisture retention, haemostasis and removal of exudates. The most promising multifunctional dressings will be tested for their antimicrobial efficacy against a range of clinically relevant pathogens, and their cytocompatibility using dermal fibroblasts, with a view to future clinical studies in diabetic patients.

Knowledge and skills required in applicant:
Applicants should have or expected to achieve a good first degree in Chemical/Biochemical/Materials Engineering or Bioscience/Microbiology and must have an interest in biomaterials. The ideal candidate must be willing to learn new techniques and to carry out laboratory-based interdisciplinary research across biological sciences and engineering**.**

2022_2023-015 - Pathways to Net-Zero: Unlocking the Potential of Bioenergy with Carbon Capture and Utilisation or Storage (BECCUS)

Supervisor: Dr Katie Chong (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Paula Helena Blanco Sanchez (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Mirjam Röder (Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Scott Banks (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)

Area of Research: Bioenergy, net-zero, climate change, sustainability, chemical engineering, techno-economic assessment, environmental assessment

Project Summary, Aim and Objectives: Are you interesting in helping to save the world? This could be the project for you!

We all know that we must work quickly to help save our planet from the threat of climate change. Bioenergy will place a critical role in achieving net-zero by replacing fossil fuels with low-carbon, renewable energy and by delivering negative emissions through Bioenergy with Carbon Capture and Utilisation or Storage (BECCUS). The aim of the project is to investigate the opportunities for capturing carbon dioxide and either using it (CCU) or storing it (CCS) in energy and industrial installations that use biomass as a feedstock. The project will combine engineering design, process modelling, techno-economics and environmental assessment.

To achieve this aim will require a logical, consistent, and accessible procedure for process synthesis and techno-economic-environmental analysis of complete BECCUS systems. The combination of techno-economics and environmental assessment is essential to demonstrate feasible net-zero solutions. This will help the UK reach its net-zero targets, by highlighting which routes are the most promising.

An important aspect of this project is the consideration of plant scale relating to the availability of UK renewable feedstocks. Demand in the future is likely to exceed sustainable supply, implying that we must use biomass resources effectively. Therefore, a critical objective of this project is to identify the BECCUS routes that deliver the highest greenhouse gas (GHG) abatement, with a focus on areas that give the greatest possible emission reductions, where no other low carbon alternatives exist (e.g. aviation).

Knowledge and skills required in applicant:
Degree in chemical engineering or equivalent
Strong numerical skills, strong Microsoft office skills, in particular Excel
Interest and initiative learning new analytical/programming skills, e.g. MatLab, Python

2022-2023-016 - Nuclear biorefinery: Novel Routes for the Production of Fuels and Chemicals Using Abundant Waste

Supervisor: Dr Vesna Najdanovic (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department, Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Andy Sutherland (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute for Materials Research)
Assoc. Supervisor: Dr Katie Chong (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department, Energy and Bioproducts Research Institute - EBRI)

Area of Research: Chemical Engineering**,** Organic Chemistry**,** Green Chemistry**,** Sustainable chemical engineering and Radiolysis.

Project Summary, Aim and Objectives: This studentship project will develop a novel radiochemical process to convert abundant and low-cost biomass-derived feedstock into high-value chemicals. This novel and green concept of a nuclear biorefinery will couple two otherwise wasted resources: radiation from nuclear plants and waste biomass.

The project will be focused on the production of high-value chemicals from glycerol, an emerging waste from biodiesel production. In Europe alone, a surplus of 1.4 million tonnes of glycerol is produced per year which cannot be used by other industries. This is expected to triple by 2030. Development of new ways to use this emerging waste addresses three socio-economic challenges: waste utilization to ensure the holistic sustainability of global biodiesel production; transition away from petrochemicals produced from finite fossil resources by using biorenewable feedstocks; and, the economic competitiveness of nuclear energy production which offers low-carbon electricity. Therefore, in long term, the project will contribute to lower carbon emissions and to address the UN Sustainable Development Goals.

You will benefit from training in the complementary disciplines of sustainable chemistry and chemical engineering and you will learn how to prepare biomass-derived feedstock and use a combination of nuclear energy sources for their conversion into useful fuels and chemicals. You will also measure the reaction yields and selectivities using various analytical methods for analysis of the liquid and gaseous products which will allow to reveal reaction mechanisms and optimise process conditions for good yields. In the final stage, the project will focus on data analysis and assessment of sustainability and profitability.

In addition to regular hands-on support by Aston supervisors, you will be supported by an external adviser from Jožef Stefan Institute (Slovenia). Knowledge exchange and dissemination will be an integral element of this collaboration which will provide opportunities for networking within the other ongoing bioenergy and nuclear engineering-related research.

Knowledge and skills required in applicant:

Applicant should have a degree in Engineering, Chemistry, Materials Science, Physics or a related discipline (at a minimum of Upper Second class honours). The applicant should demonstrate excellent oral and written communication skills with the ability to prepare presentations and reports as well as excellent interpersonal skills to work effectively in a multi-disciplinary environment.

2022-2023-017 - Explainable Artificial Intelligence for Computer Vision Applications

Supervisor: Dr Shereen Fouad (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr George Vogiatzis (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Haris Alexakis (School of Infrastructure And Sustainable Engineering; Engineering Systems and Supply Chain Management)

Area of Research: Artificial Intelligence, Deep learning, Computer vision, Explainable AI

Project Summary, Aim and Objectives: Deep learning (DL) is a subfield of Artificial Intelligence (AI), inspired by the human brains, and it has been recently considered as the backbone for numerous computer vision applications. In civil engineering, computervision techniques have been used to automatically inspect and monitor the civil infrastructure conditions.
However, the black-box nature of the DL algorithms has restricted their social acceptance and use in practical scenarios. Explainable AI (XAI) is an emerging concept which deals with the implementation of transparency and interpretability of a black-box DL methods. The majority of current XAI for computer vision tasks focus mainly on providing visual interpretation of the results by highlighting image regions, mostly influence AI models decisions. Although visual explanations are deemed useful and comprehensible by AI experts, they areoften too complex to comprehend by non-AI professionals.

This PhD research project addresses this problem by proposing an XAI method that provides a comprehensive explanation for computer vision tasks in civil engineering applications. The proposed framework will include both visual as well as verbal explanation. Verbal explanations are often easier to comprehend by non-AI professionals as they are provided in natural language form, similar to human explanations. The project will investigate innovative solutions for effective interpretation of DL processes and results. This will help explain the complete logic of making a certain decision to AI professionals, civil engineers as well as laid-back users. Toaugment the verbal explanation, advanced natural language generation tools will be investigated, including recurrent neural networks text generative models and reinforcement learning approaches. The proposed XAI solution would help build trust and acceptance for using computer vision-based civil infrastructure inspection and monitoring. This can replace the costly non-efficient manual visual inspection, leading to safer and more resilient civil infrastructure. Furthermore, the project fits well with the ongoing computer vision related research within ASTUTE.

Knowledge and skills required in applicant:
- A minimum of a UK First or Upper Second Class Honours undergraduate degree in Computer Science or related topic (Maths, Physics and Engineering).
- Experience and knowledge in software design and development using one of the AI programming languages e.g. Python or Java
- Excellent communication skills to express ideas effectively, orally, graphically and in writing.

Aston University
BIRMINGHAM UK

College of Engineering and Physical Sciences

2022-2023_018 - Self-supervised Monocular Depth Estimation

Supervisor: Dr George Vogiatzis (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Luis J. Manso (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Juan Neirotti (School of Digital Engineering; Mathematics Department)

Area of Research: Computer Vision

Project Summary, Aim and Objectives: This PhD project is a collaboration between **Aston University** and **Aurrigo Ltd**, a global leader in autonomous vehicle technology and manufacturer of autonomous passenger transportation systems.

A detailed understanding of the 3D environment structure and the motion of dynamic objects is essential for autonomous navigation. This is usually achieved through a mixture of sensors such as Li-DAR, RADAR and cameras located around the vehicle. Recently there has been a major drive by some of the major Autonomous Vehicle (AV) manufacturers to remove their reliance on Li-DAR sensors. The reasons cited include their large size, high cost as well as lack of flexibility arising from the need to have pre-mapped environments for Li-DAR localization to work. In the last two years, several Deep Learning systems have been proposed that automatically convert a simple camera feed into a depth-map feed. However, despite promising results, these systems are not yet drop-in replacements for Li-DAR because there is a significant gap in accuracy and reliability.

Our goal is to develop a **monocular depth estimation technology** that convincingly competes with state-of-the-art supervised methods of depth estimation as well as expensive sensor equipment (Li-DAR). To achieve this, we will leverage Aurrigo's experience with autonomous vehicle perception systems as well as Aston's leading research in 3D reconstruction from visual data. Alongside our main goal the PhD student will also be making contributions in the following secondary goals:

- estimating the movement of dynamic objects in an image and the camera movement. The analysis will focus mainly on self-driving vehicles and develop a method of perception understanding for the camera.
- the developing area of self-supervised learning to utilise more efficient learning of scenes.
- using monocular depth estimations for scene construction and scene understanding.
- making a detailed comparison between human perception and camera perception.

Knowledge and skills required in applicant:
Essential:

- A 1st or 2:1 in Computer Science, or related fields (Maths, Physics, Engineering)
- Excellent Python programming skills
- Good analytical/maths skills

Desirable:

- Familiarity with a neural network framework (Pytorch/Tensorflow)
- Prior experience with image/video processing.
- Interest in Autonomous Vehicles

2022-2023_019 - Development of Efficient Photocatalyst Nanomaterials for Hydrogen and Net Zero Carbon Energy Production

Supervisor: Dr Greg Swadener (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Amirpiran Amiri (Energy and Bioproducts Research Institute - EBRI)

Area of Research: Materials for Sustainable Energy

Project Summary, Aim and Objectives: Despite strong efforts by the UK and many other countries, the amounts of CO_2 and other greenhouse gasses in the atmosphere continue to rise and could well reach levels that cause disastrous effects from climate change. One promising solution is to convert the greenhouse gasses such as CO_2 and methane to useful chemical products and thus reduce the amount of greenhouse gasses in the atmosphere. Previous efforts at making catalyst systems to convert CO_2 or methane either require high temperatures, which uses too much energy, or are too costly. The approach will involve synthesis of semiconductor photocatalysts and surface plasmons resonators, characterising their photonic properties and conducting experiments to measure their effectiveness in converting greenhouse gasses and generating hydrogen.

The aim of the project is to develop efficient photocatalyst materials that will first convert greenhouse gasses to formic acid or methanol and then produce zero carbon hydrogen. The main objective is to achieve a 4-fold increase in the conversion of greenhouse gasses and the rate of hydrogen production over the current best photocatalyst systems. Photoluminescence measurements will assess electron-hole generation and charge separation. The measurements will then be compared with predictions. The best operating conditions will be explored, and hydrogen production will be measured in a lab-scale reactor. This interdisciplinary project will be linked with the Energy and Bioproducts Research Centre (EBRI) and include collaborations with materials engineering, chemical engineering, and physics.

Knowledge and skills required in applicant:
The student's background may be in materials chemistry, engineering, or physics.
Knowledge of sustainable energy and thermodynamics
Knowledge of synthesis and characterisation methods for functional materials
Some knowledge of semiconductors, photonics and/or catalysis is desirable.
Experimental skills are desirable.

2022-2023_020 - Net Zero Energy Building by Developing Low Light Intensity Photovoltaics (LLI-PV) Technology and LLI-PV Based Refurbishment

Supervisor: Dr Sungkon Moon (School of Infrastructure & Sustainable Engineering; Civil Engineering Department)
Assoc. Supervisor: Dr Kenneth Park (School of Infrastructure & Sustainable Engineering; Civil Engineering Department, Aston Institute of Urban Technology and the Environment – ASTUTE)

Area of Research: Building Integrated Photovoltaics (BIPV); Building Science; Energy Simulation; Technology Adoption; Construction Management; Building Information Modelling (BIM); Whole Life Management; Net-zero energy (nZE)

Project Summary, Aim and Objectives: The housing sector in the UK has been faced with challenges: climate change, the environmental effect, and the lack of real-time information integration. New technologies, such as BIM and renewable energy, are essential to alleviate these problems. The housing sector in Birmingham has been increasingly exhorted to adopt them as they make it possible to construct higher-performing buildings, with less environmental impact and improved whole-life performance.

The nZE concept stems from this phenomenon, which can be actualised by maximising the use of renewable energy. This project focuses on photovoltaics technology combined with new technologies, and its application to residential buildings in Birmingham. The main problem in BIPV is the lack of research with the low light intensity. Mainstream inorganic solar cells, such as silicon and GaAs, do not perform optimally in the situational environmental conditions of existing buildings, which makes the critical limitations. This conditional difference creates a considerable discrepancy between electricity generation and the entire efficiency.

The research aims to develop an optimised system of nZE via LLI-PV technology supported by scan-to-BIM. It also includes the system implementation and assessment in Birmingham. The highly fragmented nature of current construction practices necessitates the development of a reliable system for affordable housing in Birmingham to support and guide the introduction of effective energy and carbon emission management. The developed system will also be available to ensure the integration of required information throughout the life cycle.

This presented project will cover three phases: (1) Development of the LLI-PV technology with optimal band gaps (1.8-2.0 eV) for the low light intensity spectrum; (2) Information integration and subsystem development by new technologies, such as scan-to-BIM; and (3) Applying and assessing the developed system.
By utilising wide-bandgap halide perovskites, the developed LLI-PV technology aims for a highly efficient system while accomplishing decarbonated building in Birmingham.

Knowledge and skills required in applicant:
UG/PG in Construction/Civil/Architectural Engineering and Computer Science or similar field.
Ability to develop own research in innovative and technology-based research topic to postgraduate level and research writing skills.
Experience of using various relevant tools and data analyses such as Python, MATLAB, iSEE, iDEF, Autodesk Products, etc.

2022-2023_021 - Machine Learning Approaches to Support the Development of Phage Therapies

Supervisor: Felipe Campelo (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Aniko Ekárt (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Gabriel M.F. Almeida (The Artic University of Norway)

Area of Research: Bioinformatics, Machine learning, Data Mining, Optimisation

Project Summary, Aim and Objectives: Bacteriophages (also known simply as phages) are a class of viruses that infect bacteria. Although not a new concept, phage therapy has been increasingly studied as one of the most promising approaches to tackle the problem of antibiotic-resistant bacterial infections, both for humans and economically relevant animal species. Current approaches for the development of specific phage therapies are intensively resource- and time-consuming, requiring the experimental

investigation of hundreds of potential candidates to find one that is effective for the treatment of any specific bacterial infection. Some of the essential topics in the development of phage therapies include: Predicting the immune response of the patient against the phage, which can limit the usefulness for treating systemic infection; Matching known phages against specific bacteria; Optimising phage combinations for anti-bacterial cocktails; and Screening of phage libraries for specific objectives (e.g., mucus adherence, anti-CRISPR properties).

The aim of this project is to explore Machine Learning approaches to leverage existing data and provide researchers with effective target prioritisation tools to enable faster, cheaper and more reliable development cycles in phage therapy research. The main objectives include: (i) development of models to detect which proteins from phages are more likely to elicit an immune response from humans, as a way to select (and eventually design) phages that are more suitable for the treatment of systemic infections; (ii) exploration of predictive approaches to identify phage hosts based on genomic and proteomic data; (iii) creation of a prescriptive data pipeline to identify and recommend phages / phage combinations for treating specific bacteria on different niches of the body; and (iv) development and deployment of online, publicly-accessible tools to enable domain experts to access these models and export the predictions and analyses in an easily accessible, reproducible manner.

Knowledge and skills required in applicant:
Essential: Data mining; Machine Learning; Optimisation; Good experience with R and/or Python programming.
Desirable but not essential: knowledge of general biology, immunology, bioinformatics.

2022-2023_022 – Digital Twin-Enabled Wearable Sending Technologies for Work Related Assessment In Construction

Supervisor: Dr axwell Fordjour Antwi Afari (School of Infrastructure and Sustainable Engineering; Civil Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Kenneth Park (School of Infrastructure and Sustainable Engineering; Civil Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Construction Informatics, Construction Management, Construction Ergonomics, Construction Health and Safety, Wearable Sensors and Robotics, Internet of Things, Building Information Modelling

Project Summary, Aim and Objectives: Construction workers are frequently exposed to various manual repetitive handling tasks such as a plastering or rebar tying, which lead to associated risks for developing work-related musculoskeletal disorders (WMSDs). Almost half million workers in the UK are suffering from new or long-standing WMSDs in 2019/20. The high prevalence rate of WMSDs in construction not only causes work absenteeism, increased the cost of insurance premium but also lead to loss of productivity and early retirement.

Numerous studies have been conducted on the identification of potential work-related risk factors by using traditional approaches such as self-reports and observational methods. Recently, wearable sensing technologies have been implemented to identify potential work-related risks whilst providing personalized feedback for self-awareness and ergonomic risk level assessment. However, there is still hidden knowledge in data collection for ergonomic risk level assessment with associated work-related risks. To address these limitations, it is important to implement a digital model of work-related risks while conducting workplace activity to create an objective visualization of the physical environment.

Therefore, the overarching goal of this research project is to develop a closed-loop digital twin framework by integrating wearable sensing technologies, virtual reality/augmented reality (VR/AR) approaches, and data mining techniques for work-related risk assessment. The specific research objectives are: (1) To design a rational framework of a digital twin by integrating wearable sensing technologies, AR/VR, and data mining techniques to support intelligent self-assessment of work-related risks; (2) To validate the proposed digital twin framework and work-related risk assessment at a construction site. Overall, this project will help to identify the hidden knowledge in data collection and ergonomic risk assessment for mitigating WMSDs. This research aligns with ASTUTE's research vision, serving as a component of digital engineering.

Knowledge and skills required in applicant:
Undergraduate degree (First class or Second class upper) or Master degree programmes in Construction Management, Engineering (Civil/Computer/Mechanical, Architectural, etc.), Quantity Surveying or other closely related disciplines. Preferred skills include background in computer programming, signal processing and computational data analyses (e.g., machine learning)

2022-2023_023 - Compact and Responsive Sorption Thermal Energy Storages: Material Development, Experimental Characterisation and Modelling

Supervisor: Dr Ahmed Rezk (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Richard Martin (School of Digital Engineering; Electrical, Electronic and Engineering Department)

Area of Research: Thermal energy storage and upgrading

Project Summary, Aim and Objectives: The annual demand for heating is 4.9 Billion tonnes of oil equivalent worldwide. In the UK alone, the heating demand is 52.5 Million tonnes of oil equivalent (MToe) that accounts for 38% of the nationwide energy demand, while the heat wasted in the industrial sector is 3.4 MToe. Thermal energy storage (TES) is crucial to decarbonise such vast amounts of heating in domestic and industrial sectors. It provides heat load shifting capability by decoupling the heat supply and demand, which enables: (1) utilising the intermittency of renewable energy resources (e.g., solar thermal, geothermal and PV driven electric heaters), (2) maintaining the operation of smaller heating equipment at peak efficiency conditions (e.g., electric heat pumps and micro combined heat and power systems), and (3) transporting surplus thermal energy for later use to promote the concepts of heat sharing networks. Recent studies reported the capability of heat storage to reduce energy consumption by more than 60% and CO_2 emission by 50%.

Chemical and physical sorption TES is the next-generation technology that provides the highest possible storage density compared to the other alternative technologies. However, the poor thermal performance of the existing working substances bottlenecks the development of effective systems. To fill the knowledge gaps and achieve a paradigm shift in sorption heat-storing, the project aims to develop new materials and component designs to overcome the heat and mass transfer limitations, miniaturising and accelerating the rate of heat charging / discharging in sorption-based heat storage. The research to be undertaken requires material selection, formulation of new composite sorbents by utilising carbon-based hosting structures, detailed material characterisation, develop a tool to optimise the composites formulation and empirical modelling of the developed materials. State-of-the-art laboratory facilities for material thermal and sorption characterisation and rapid prototyping are available to accomplish this work at Aston University.

Knowledge and skills required in applicant:
The project is open for applicants from Physical sciences, including Mechanical Engineering, Chemical Engineering, or Chemistry backgrounds. The applicant should show the willingness to gain new skills concerning material formulation and characterisation. The applicants will submit a research proposal to demonstrate their ability to undertake outstanding research and plan efficiently to achieve the project's aim.

2022-2023_024 – Bioinspired Wound Dressing

Supervisor: Dr Anisa Mahomed (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute for Urban Technologies and the Environment - ASTUTE / Aston Institute for Materials Research)
Assoc. Supervisor: Professor Brian Tighe (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute for Urban Technologies and the Environment - ASTUTE / Aston Institute for Materials Research)

Area of Research: Hydrogels, Wound dressings, Biomaterials, Polymers

Project Summary: Wounds that fail to progress through the healing phases and show no significant progress towards healing in a timely manner are known as chronic wounds. The prevalence of these is growing at a rate of 12% per year in the UK and this exerts an increased economic burden on the NHS.

Chronic wounds are managed through the use of medical wound dressings. These cover and protect a wound, and may also promote epithelialisation, autodebridement, granulation and moisture regulation. Most dressings are not effective in stimulating chronic wound healing. However, some hydrogel based dressings have been considered to be effective for chronic wound care. This group of synthetic hydrogels can be designed to mimic the extra cellular matrix and their properties can thus be designed to match the requirements of an ideal wound dressing. Hydrogels can create a moist wound healing environment, absorb excess exudate, allow gaseous exchange and can be removed easily without causing trauma to the wound. The ability of hydrogels to absorb exudate leads to autolytic debridement which is vital for the successful healing of a chronic wound. However, a drawback of hydrogels is their low mechanical strength, particularly when swollen. To manage this, they are fabricated with a suspended mesh or are used in conjunction with a secondary dressing.

This exciting project will, in particular, use cutting edge polymer science principles to develop and design ecological and cost-effective hydrogel dressings that promote the healing of chronic wounds. In turn, this will provide a basis for a new platform technology in the evolution of wound dressings.

The aim of this project will be to:

1. develop a molecular interpenetrating network composite hydrogel structures of adequate strength
2. optimise the polymerisation process and stability during processing
3. develop suitable lab fabrication processes that combines optimised structures, polymerisation and properties.

Knowledge and skills required in applicant:
A 1st Class degree in chemistry, material engineering, biotechonology, chemical engineering or similar
Understanding of polymers and materials

Ability to plan and undertake lab work unsupervised
Quick starter, self-learner, flexible to the needs of the project and willing to take on challenges
Have work experience.

2022-2023_025 - Designing Sustainable and Circular Engineering-to-Order Supply Chains

Supervisor: Dr Yasmine Sabri (School of Infrastructure and Sustainable Engineering; Engineering Systems and Supply Chain Management Department)
Assoc. Supervisor: Dr Brian Price (School of Infrastructure and Sustainable Engineering; Engineering Systems and Supply Chain Management Department)

Area of Research: Engineering to order supply chains, Engineering/Industrial projects-based supply chains, Engineering-Procurement-Construction (EPC) supply chains, supply chain management, engineering management.

Project Summary, Aim and Objectives: Major industrial projects provide the greatest opportunity to integrate sustainability and circular economy thinking, to maximize the benefits of these approaches for commercial and environmental gain. This project aims to explore methods for structured application of sustainability and the circular economy to engineering-to-order projects.
There is a growing interest in the UK to shifting towards more circular economy and green growth, which currently shapes national policy development (UK Gov, 2021). This is particularly relevant in sectors such as engineering projects sector* which accounts for a significant consumption of natural resources, in which recent estimates point that engineering projects-based supply chains consume nearly 50% of global steel production, and constructed assets are estimated to be responsible for 25-40% of the world's total carbon emissions. Hence, these supply chains face a growing pressure to transition to be more sustainable (Strandhagen et al., 2020). The development of this sector is strategic to many governments as it contributes by 6% to the global GDP and 8% in developing countries, where it was estimated that a 1% rise in productivity may save up to USD100 Billion a year (Renz *et al.*, 2016). In the UK context, engineering projects-based supply chains contribute by circa a fifth (20%) to the UK's economy, spanning across multiple sectors; such as, oil & gas, nuclear, renewables, chemicals, pharmaceuticals, water and waste treatments. Many small, medium and large businesses are part of this extended supply chain network and constitute nearly 90% of the core sector workforce in the UK (Labour Market Outlook ECITB, 2019).
Circular economy literature, being a nascent research, provide limited models to help measure the level of adoption of CE practices in a strategic economic sector such as Engineering-to-Order (ETO) supply chains. Similarly, there is a paucity of research to help understand the impact of such adoption on the supply chain's sustainability performance. As such, the aim of this research is twofold; first to establish the state of adoption of circular economy practices, and second, to investigate the impact of such adoption of circular economy practices on triple bottom line sustainability performance of ETO supply chains. This research will offer a comprehensive framework to guide supply chain managers and researchers in identifying which circular economy practices have the highest impact on sustainability performance and therefore should be prioritised.

***** Investments in the engineering sector are typically executed in the form of mega capital-intensive multi-stakeholder projects with three major stages: Engineering, Procurement and Construction (EPC). As the decoupling point is in the engineering phase, this type of supply chain is referred to as Engineering-to-Order (ETO), projects-based, or EPC supply chains.

Knowledge and skills required in applicant:

We are looking for highly motivated applicants, with analytical skills and eagerness for continuous learning and improvement.

Essential Requirements:

- The successful applicant should have a first class or upper second class honours degree or equivalent qualification in one of these fields: Supply Chain Management, Logistics and/ or Systems Engineering
- Appreciation and understanding of Procurement and Project Management concepts
- Understanding of projects-based supply chains (demonstrated through an academic qualification and/or professional experience)
- Experience in applied research methodologies (demonstrated through empirical data collection and analysis)
- Advanced communication and academic writing skills.

Desirable Requirements:

- Experience in researching circular economy and sustainability concepts
- Professional experience in an ETO supply chain environment (for example: Oil &Gas, Chemicals, and/or Pharmaceuticals)
- Professional experience in implementing sustainability and/or circular economy in ETO supply chain environment

2022-2023_026 - Optical Spectroscopy for Agricultural and Food Samples Monitoring

Supervisor: Dr Alex Rozhin (School of Digital Engineering; Electrical and Electronic Engineering Department, Aston Institute of Photonic Technologies - AiPT)
Assoc. Supervisor: Professor Igor Meglinski (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)

Area of Research: Photo-physics or photo-chemistry of soft and organic materials, Optical spectroscopy, Optical sensors

Project Summary, Aim and Objectives: Household and industrial food waste are the main environmental pollutants. Therefore, the issue of developing sensor systems for the food and agricultural industries is of serious economic and social importance. The problem of this area is that there are very many sources of pollution of foods, including fertilizers, micro/nano plastic, bacterial contamination etc. Additionally, the composition of plant and animal products is very dependent on the biochemistry of soil, which is used for plant growth or animal graze. The food industry still depends on the methods of the 19th century to control the quality of the products, which are mainly based on long-term bacterial analysis in Petri dishes. In most cases, the analysis requires high precision and expensive equipment and highly qualified personnel. Hence, the cost of the analysis is high and is unaffordable to small producers and retailers.

Optical spectroscopy has a great potential for use in the food and agricultural industries. Testing of samples can occur both in the liquid and solid phases, enabling to define of chemical and bacterial pollution as well as biological components of plant and animal products.

Within the framework of this project, we plan to perform study with the following Research Objectives: (1) development of efficient sampling protocols for optical spectroscopy characterisation of food samples with high-performance UV-NIR and photoluminescence spectrometers; (2) building USB based

spectrometer for express analysis of food samples. We aim at the creation of a library of different food fluorophores, which will be accessible by scientists, SMEs and the public via comparison of express spectroscopic data with high-performance data.

Knowledge and skills required in applicant:
Preferable candidate needs to have knowledge of photo-physics or photo-chemistry of soft and organic materials. The experience of using optical spectrometers such as Perkin Elmer Lambda 1050 and Horiba Nanolog (photoluminescence) will be an advantage. Technical skills in working with chemical processes such as mixing, filtration, centrifugation are essential.

2022-2023_027 - New Advances in Optimisation and Design of Energy Piles to Support Net Zero Energy Building

Supervisor: Dr Moura Mehravar (School of Infrastructure and Sustainable Engineering; Engineering Systems and Supply Chain Management Department / Aston Institute of Urban Technology and Environment - ASTUTE)
Assoc. Supervisor: Professor Patricia Thornley (Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Nikolaos Tziavos (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)

Area of Research: renewable energy, geo-energy, energy piles, numerical modelling, finite element analysis, optimization, thermo-hydro-mechanical modelling

Project Summary, Aim and Objectives: The concept of net zero energy building (NZEB) aims to design and construct buildings with less energy consumption and low carbon emission. Over the past 10-15 years, integrating heat exchanger pipes in geo-structures for space cooling and heating of buildings has received increasing attentions. This environmentally friendly technology can be applied to all types of soil-embedded structures such as diaphragm walls, tunnels, shallow foundations, and piles. Among all these types of geo-structures, the energy pile remains the most common application for the ground heat exchange process. Many studies have been carried out to assess the performance of energy piles using experimental tests, analytical methods, and numerical modelling. However, design and installation of energy piles remains a challenging and complex process due to the interaction between the activated piles and ground (thermo-hydro-mechanical).

This study aims to investigate the thermo-hydro-mechanical interaction between energy piles and ground using advanced numerical modelling procedures including development of a fully coupled finite element (FE) model and the use of AI to accurately predict the complex performance of energy piles, expands knowledge on their evaluation criteria and key parameters, investigate their long-term performance and provides design recommendations.

The detailed research objectives (ROs) are to:
(RO1) Develop a fully coupled numerical model to accurately simulate the behaviour of a system of concrete piles, a working fluid and ground to capture complex interrelationships of these three phases as well as individual roles of physical contributing parameters. The model will be validated against well-established data from literature

(RO2) Develop a life cycle assessment model to compare the environmental performance of energy piles vs. a group of conventional piles

(RO3) Develop a framework to optimise design of energy piles considering thermal, mechanical, economic and environmental perspectives. This will be facilitated by developing a series of innovative physics-informed artificial intelligence algorithms that will integrate FE analysis and machine learning to capture complex relationships of contributing factors while providing efficient solutions.

(RO4) Develop a design guidance to assist practitioners during the decision making and design steps thereby facilitating the uptake of the outcomes of this research ultimately leading to a more efficient use of energy piles.

Knowledge and skills required in applicant:
Civil/Geotechnical Engineering, Mechanical Engineering, Chemical Engineering, Mining, Physics and Applied Mathematics]. Preferred skill requirements include knowledge/experience of finite element analysis (COMSOL Multi-physics), Optimization techniques, Multi-phase modelling including thermo-hydro-mechanical modelling.

2022-2023_028 - Novel Alkaline Thermal Treatment of Biomass for Hydrogen Production and Carbon Capture

Supervisor: Dr Jude Onwudili (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Professor Patricia Thornley (Energy and Bioproducts Research Institute - EBRI)

Area of Research: Catalytic thermochemical conversion; modelling and analysis

Project Summary, Aim and Objectives: The production and use of hydrogen as fuel is a hot research topic due to its potential to help achieve Net Zero by 2050, with no direct carbon emissions during its combustion. Commercial quantities of hydrogen can be produced from vastly available and sustainable biomass feedstocks such as forestry residues, agricultural wastes and manures, energy crops and organic wastes. The UK is projected to generate about 1000 PJ of sustainable solid biomass by 2030. Using an average calorific value of 18 GJ/tonne, this translates to nearly 60 million tonnes of UK solid biomass per year by 2030, some of which can be used for hydrogen production via a range of technologies. Traditional thermochemical technologies like gasification and high-temperature pyrolysis tend to suffer from low conversion efficiencies, costly downstream processing to obtain purified hydrogen and end-of-pipe carbon capture. The unavoidable co-production of carbon dioxide during thermochemical processing of carbon-based feedstocks for hydrogen production is a major challenge for sustainability and process economics. In this project, a novel technology is proposed that uses alkaline thermal treatment (ATT) to process solid (wet and dry) biomass to produce syngas composed of hydrogen and methane, while simultaneously capturing the carbon dioxide, leading to net negative carbon emissions. The process can occur at moderate temperatures of around 400 - 600 °C and at atmospheric pressure. Potentially, more hydrogen can be made from the methane co-product via reforming. The focus of this research is however, to develop the initial ATT stage, by testing a range of UK-based biomass feedstocks in the presence of various alkaline materials. In addition, a range of reaction conditions will be investigated to optimise biomass conversion and enhance the yields of hydrogen. Therefore, this PhD research project will involve laboratory work, modelling, detailed analysis of experimental data and writing-up of results.

Knowledge and skills required in applicant:
Demonstrable knowledge of hydrogen production technologies, catalysis, organic chemical reactions, mass and energy balances and chemical engineering unit operations for process synthesis, analysis and

design. Possess or have capability to develop research skills in laboratory experimentation, materials characterisation, modelling, handling and processing of experimental data, academic report writing and presentation.

2022-2023_029 - Dynamic Modeling and Control Strategy of Organic Rankine Cycle for Industrial Waste Heat Recovery Applications

Supervisor: Dr Muhammad Imran (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Jose Ricardo Sodre (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department, Aston Institute of Urban Technology and the Environment - ASTUTE / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Professor Patricia Thornley (Energy and Bioproducts Research Institute - EBRI)

Area of Research: Mechanical Engineering

Project Summary, Aim and Objectives: Waste heat from industrial processes is intermittent and characterised by fluctuations in temperature and mass flow of the waste heat, making it a difficult task to operate and control the organic Rankine cycle (ORC) to ensure safe operation and maximum power output. The transient waste heat source can cause severe damage to the components of the ORC system, especially expansion machine. The intermittent and transient nature of heat source forces the ORC system to operate far from the design-point power capacity, thus deteriorating its performance and economic potential. Therefore, it is of crucial importance to investigate the dynamic response of ORC system and develop a suitable control strategy for the ORC system for industrial applications, ensuring safe operation, long life of the ORC unit and maximum performance under varying conditions of the waste heat.
This 3 year fully funded PhD project seeks to develop the optimum design, component level dynamic model, and optimum control strategy of an organic Rankine cycle for waste heat recovery from energy intense industries. The industry partner will provide the waste heat data, which will be used to develop the preliminary design of the ORC system. The preliminary design will be extended to 1-dimensional component level model and dynamic model of the system. The modeling work will be carried out either in the MATLAB or in Modelica language. Based on the results of the dynamic model, a non-linear model predictive controller will be designed and optimised. The dynamic model and controller will be experimentally validated with the data provided by the ORC manufacturer.
This project will resolve a major barrier for successful commercialisation of the ORC system and can be widely applied to energy intensive industrial sectors such as the iron and steel industry, ceramic manufacturers, cement factories, food industrial, etc.

Knowledge and skills required in applicant:
Basic programming skills in Matlab or object oriented language, thermodynamic modelling, heat transfer, heat engines, power cycle.

2020-2023_030 - Vagus Nerve Stimulation: an Alternate Therapy for Stress Rehabilitation

Supervisor: Dr Surej Mouli (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering)

Assoc. Supervisor: Dr Antonio Fratini (School of Engineering and Technology; Mechanical Biomedical and Design Engineering)

Area of Research: Biomedical Engineering, Neuroscience, Vagus Nerve Stimulation (VNS), Stress reduction, Neuromodulation

Project Summary, Aim and Objectives: Stress and anxiety are becoming more and more relevant in modern society, with a considerable rise in anxiety-related disorders. It thus becomes apparent that stress is increasing mental health conditions, which requires attention towards the development of a quantifiable relief strategy.

To address these issues and to minimise the adverse side effects of drugs, alternative treatments have been sought in recent years. Notably, methods based on nerve stimulation are being explored widely. Such methods are sometimes referred to as neuromodulation due to their ability to modulate the nervous system response.
Amongst various neuromodulation techniques, vagus nerve stimulation (VNS), via the use of implanted or invasive devices, is an established technique. The FDA has recently approved VNS for therapeutic use.

Recent studies have focused on non-invasive methods of VNS, which can circumvent complex implantation procedures and associated risks, such as infections.
This project aims to evaluate the effect of non-invasive VNS; this involves stimulation of the auricular branch of the vagus nerve via an externally applied device and the use of EEG and HRV features as measures of change in stress levels.

Aim: To develop a customisable auricular VNS hardware platform to study the effect of stimulation parameters and their influences stress reduction.

Objectives:
- Evaluate the change in stress levels during specifically assigned tasks, using heart rate variability metrics (LF/HF, and alike), EEG and questionnaires.
- To develop a VNS platform with customisable stimulation parameters (e.g., waveforms, frequency, pulse rate and alike) to stimulate the auricular branch of the vagus nerve.
- To identify the key stimulation parameters for reducing and managing stress levels.

Knowledge and skills required in applicant:
The successful applicant should have a first class or upper second-class honours degree in biomedical engineering, neuroscience, computer science, electronics or a related subject. Preferred skill requirements include knowledge/experience of electrophysiology, electronics, microcontroller-based design, experimental analysis, basic programming e.g. MATLAB/Python.

2022-2023_031 - System Integration and Development of Hybrid Power Train Using Fuel Cells for the Automotive Industry

Supervisor: Dr Tabbi Awotwe (School of Engineering and Technology; Mechanical Biomedical and Design Engineering Department / Aston Institute of Urban Technology and Environment - ASTUTE)
Assoc Supervisor: Dr Jose Ricardo Sodre (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department, Aston Institute of Urban Technology and the Environment - ASTUTE / Energy and Bioproducts Research Institute - EBRI)

Assoc. Supervisor: Dr Abed Alaswad (School of Engineering and Technology; Mechanical Biomedical and Design Engineering Department / Energy and Bioproducts Research Institute - EBRI)

Area of Research: Sustainable Energy and Transport

Project Summary, Aim and Objectives: The aim of this project is to develop a hybrid powertrain testing and EV powertrain test bench to ascertain the dynamics of pure electric and hybrid drive systems coupled with the simulation of the energy consumption of the operating conditions, motor and controller efficiency and the technical indicators of the drive system components. The vehicle energy conditions, and control strategy will be investigated via the simulation of actual working condition of the vehicle. The project is built out of the recently acquired Magtrol dynamometer and Fuel cell via the GBSLEP and UKRI World Class Equipment grant respectively. The test bench will further be designed for functional test and performance test for hybrid and parallel hybrid power systems in hybrid power and pure electric vehicle. Development, matching coupled with calibration of new energy power system as well as driving motor will be investigated.
Objectives
1. Investigation into the vehicle control strategies (energy allocation strategy and braking energy feedback strategy.
2. Study into vehicle dynamic simulation test (work condition simulation)
3. Assessment of reliable performance test of relevant high-voltage components such as motor efficiency, speed characteristics, torque characteristics and motor control
4. Evaluation of dynamic performance and fuel economy performance test for user-defined cyclic work conditions
5. Analysis of performance test of engine torque, speed response and other relevant standards.
of this project is to develop a hybrid powertrain testing and EV powertrain test bench to ascertain the dynamics of pure electric and hybrid drive systems coupled with the simulation of the energy consumption of the operating conditions, motor and controller efficiency and the technical indicators of the drive system components. The vehicle energy conditions, and control strategy will be investigated via the simulation of actual working condition of the vehicle. The project is built out of the recently acquired Magtrol dynamometer and Fuel cell via the GBSLEP and UKRI World Class Equipment grant respectively. The test bench will further be designed for functional test and performance test for hybrid and parallel hybrid power systems in hybrid power and pure electric vehicle. Development, matching coupled with calibration of new energy power system as well as driving motor will be investigated.
Objectives
1. Investigation into the vehicle control strategies (energy allocation strategy and braking energy feedback strategy.
2. Study into vehicle dynamic simulation test (work condition simulation)
3. Assessment of reliable performance test of relevant high-voltage components such as motor efficiency, speed characteristics, torque characteristics and motor control
4. Evaluation of dynamic performance and fuel economy performance test for user-defined cyclic work conditions
5. Analysis of performance test of engine torque, speed response and other relevant standards.

Knowledge and skills required in applicant:
The candidate have a strong background on controls, automotive engineering, thermodynamics, Combustion and Internal Combustion Engines. It is highly desirable previous experience in engine test and emission measurements. Skills on engine control, fuel chemistry and fuel additives will also be appreciated.

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2022-2023_032 - The Future of Forests In Sub-Saharan Africa

Supervisor: Dr Mirjam Röder (Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Katie Chong (Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Lucy Bastin (Aston Institute of Urban Technology and Environment - ASTUTE)

Area of Research: Sustainable forest management, biomass use, bioenergy, carbon modelling, greenhouse gas emission assessment, geographic information systems (GIS), remote sensing.

Project Summary, Aim and Objectives: Are you interested in helping developing countries to tackle climate change? This PhD project will investigate the carbon balances and sustainable biomass use from forests in Sub-Saharan Africa (SSA).

The project is of interest to students who want to work in sustainability, climate change mitigation, renewable energy or forests related topics and engage with people. You will use different research methods, analyse historical data, develop future scenarios and work with external organisations, businesses and policymakers. You will be part of a vibrant interdisciplinary team, collaborating with researchers from different career levels and discovering future employment opportunities and career pathways.

Over 70% of the population in SSA depends on forests for their livelihood. In addition, forests supply about 60% of all energy in SSA, as fuelwood and charcoal, often sourced and used unsustainably. Deforestation, health risks from air pollution and climate change emissions when burning wood or charcoal are a result. The unsustainable sourcing is reflected by the continuous level of deforestation and forest degradation in SSA.

This PhD will investigate how forest management practices need to change to allow afforestation, improve forest carbon stocks and sustainable wood use. At the same time, this must not compromise the energy supply of people, communities and industries that supports livelihoods and economic development.

In this PhD project, you will use carbon modelling, land cover/land use assessment, GIS / remote sensing, and lifecycle assessment to evaluate the forest cover and carbon dynamics of different forest types and management practices. In addition, you will investigate the measures required to reduce deforestation and unsustainable forest management, including understanding why deforestation occurs and reviewing best practice in community forest management. Based on this, you will design sustainable business models for forest management and the transition of unsustainable wood use to sustainable practices supporting livelihoods and economic development.

Knowledge and skills required in applicant:
Understanding of sustainability (environmental, economic, social), renewable energy (preferably bioenergy), climate change, carbon cycle dynamics. Good numerical skills. Interest in forests, GIS, and modelling. Enthusiasm to work in an interdisciplinary team, work with people outside academia and learn new skills.

2022-2023_033 – Sustainability of Socio-Ecological Systems in the SUE Model

Supervisor: Dr Roberto Alamino (School of Digital Engineering; Mathematics Department)
Assoc. Supervisor: Dr Breno Nunes (College of Business and Social Sciences, Aston Business School / Centre for Circular Economy and Advanced Sustainability)

Area of Research: Stochastic processes and statistical physics applied to sustainable management

Project Summary, Aim and Objectives: The main goal of this project is to investigate the regimes of sustainability of a statistical physics model representing a simplified socio-ecological system consisting of two interacting systems: a society and an environment. The work will be based on a previous proposal by the main supervisor (Dr R.Alamino) and collaborators called the SUE model, introduced to study the limits of sustainability in systems where both environmental impact and social well-being are considered simultaneously.

The model parameters of the social component are based on variables extracted from the social sciences and business literature, while the environment is modelled after well-known ecological models. The relevant parameters include the interaction strength between the social and ecological components, the interaction between agents in the social network and the social and environmental limits characterising the collapse of the system. The latter are the main parameters which define the sustainability of the composed system.

The goals of this project are:
1. Define the range of model parameters (through the use of computer simulations and analytical studies) which guarantees that the long term dynamics is free from either social or environmental collapse, i.e., the system's sustainability range.

2. Create variations of the model able to achieve better qualitative agreement with actual empirical data.

3. Propose recommendations to guide the design of sustainable policies by indicating key aspects in which they should focus to get more efficient results and avoid collapse.

References:

Nunes, B., Alamino, R.C., Shaw, D., Bennett, D., Modelling sustainability performance to achieve absolute reductions in socio-ecological systems, Journal of Cleaner Production 132, 32 (2016
Knowledge and skills required in applicant:
This project requires both analytical and computational skills involving the following topics: Stochastic Processes, Dynamical Systems and Networks. A knowledge of Statistical Physics would be desired, but not essential.

2022-2023_034 - New Methods for Characterisation of Brain Dynamics, Corticomuscular Networks and Sensory-Motor Reconfiguration in Perturbation-Based Balance Assessment

Supervisor: Dr Antonio Fratini (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Surej Mouli (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)

Area of Research: Biomedical Engineering, Neuroscience, Brain and muscle dynamics

Project Summary, Aim and Objectives: Controlling posture while ensuring body stability is a key task of the central nervous system (CNS). An age-related development/decline of this motor ability is always assumed, but key fundamental questions are still open, explaining the constant rise in people with functional limitations and falls related consequences.
Recent advances have revealed a more articulated picture of the neuromuscular underpinnings of bipedal stance: from the simple hypothesis of reflex contraction strategies, we now know that posture and balance control involve interaction and adaptation of the CNS and the complex network of skeletal muscles. With high-density electroencephalography (HD-EEG) and source reconstruction algorithms, we are now able to highlight the strength of activity and reconfiguration of areas of the brain related to specific tasks. Similarly, anatomical muscle network (AMNs) analyses can highlight corticomuscular coherence and new muscle networks synergies.
This project capitalises on previous and ongoing research within the Biomedical Engineering Research Centre, developing further knowledge and methods to help in assessing balance control.

Aim: To identify of neuromuscular markers of balance control via advanced electrophysiology analyses in perturbation-based balance tasks.
Objectives:
• Map the connectivity patterns of brain-muscle networks supporting postural control across age groups;
• Identify neuromuscular signatures of balance control;
• Assess the contribution of different sensory pathways through perturbations of vestibular, visual, and somatosensory systems.

Aston University owns state-of-the-art academic and clinical facilities equipped with latest electrophysiology and motion capture technologies, including and relevant for this project:
• Dense array multichannel EEGs, sEMG 12 bipolar channels integrated with the EEG equipment
• Vicon Vero 2.2 motion capture with AMTI Force platforms
• Equitest Dynamic posturography system
• Additional clinical facilities as a MEG and an MRI are also available on site (https://www.aston.ac.uk/research/hls/ihn).

The proposed project will benefit from collaborations with clinical and academic international partners (The Birmingham Women's and Children's Hospital Trust, University of Rennes, Reykjavik University.

Knowledge and skills required in applicant:
First or upper second-class honours degree in biomedical engineering, neuroscience, mathematics, computer science or related subject. Preferred requirements include: experience in electrophysiological measurements, experimental analysis, programming (e.g.,MATLAB). Aston is committed to the principles of the Athena SWAN Charter, and we pride ourselves on our vibrant, friendly and supportive working environment.

2022-2023_035 - ECG Modelling for Automation of Routine Tests Interpretation.

Supervisor: Dr Laura Rebollo-Neira (School of Digital Engineering; Mathematics Department)
Assoc. Supervisor: Dr Felipe Campelo (School of Digital Engineering; Computer Science Department)

Area of Research: Applied Mathematics, Artificial Intelligence

Project Summary, Aim and Objectives: Electrocardiography (ECG) is the process of recording the electrical activity of the heart. The shape and variation of the ECG record embody information that an expert diagnostician can interpret to assess the physiological state of a patient.

The central aim of this project is to develop a principled approach for modelling and interpreting heart beats in ECG records. The plan is to extend recently proposed models for sparse representation of ECG signals [1,2,3], and dedicate them to tackle the problem of automatic diagnosis of heart anomalies.

Sparse representation of heart beats provides a natural framework for feature extraction, by representing different classes of beats as superposing of few elementary components that are extracted from large dictionaries of dedicated shapes. The dictionaries can either be learned from available data or proposed within a robust mathematical framework [1,2,3]. The idea of this project is to consider both approaches simultaneously in the development of an expert system for classification of EEG signals.

Sparse representation techniques are in general computational demanding. Besides working on the theoretical framework required to develop effective representations for EEG signals, significant efforts will also be dedicated to achieve computationally effective implementation of the proposed classification pipeline, to make the resulting system applicable for, e.g., embedding into medical devices for real-time classification and diagnostic support.

[1] Rebollo-Neira, L. & Cerna D. , 2019, Wavelet Based Dictionaries for Dimensionality Reduction of ECG Signals, Biomedical Signal Processing and Control, 54, 101593.

[2] Cerna, D. & Rebollo-Neira, L., 2021, Construction of wavelet dictionaries for ECG modeling, MethodsX. 8, 20 p., 101314.

[3] -Chagnon, J. & Rebollo-Neira, L, 2020, Mixed-transform based codec for 2D compression of ECG signals, Biomedical Signal Processing and Control. 62, 10206.

Knowledge and skills required in applicant:
In addition to aspiration to learn, the ideal candidate should have a demonstrable aptitude for applied mathematics and be interested in developing advanced programming skills. Candidates from Mathematics, Computer Science, Physics, Engineering and related fields are welcome.

2022-2023_036 -Early Age Performance of Ultra-High Performance Grouts for Offshore Wind Turbine Support Structures

Supervisor: Dr Nikolaos Tziavos (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)
Assoc. Supervisor: Dr Moura Mehravar (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)
Assoc. Supervisor: Professor Mujib Rahman (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)

Area of Research: Structural Engineering, numerical modelling, finite element analysis, offshore wind structures

Project Summary, Aim and Objectives: Offshore wind is one of the lower cost energy solutions in the UK and one of the main drivers to achieve net-zero targets. Currently, the UK is a world leader in offshore

wind energy and aims to generate one third of its electricity from offshore wind turbines by 2030. To achieve this, remote locations ought to be explored to facilitate the installation of new windfarms in harsher environments and deeper water.
The majority of the commissioned offshore wind turbines are installed on fixed-bottom structures, such as monopiles and jackets, which are being scaled up progressively to accommodate larger turbines to meet the increasing demand.

For such substructures grouted connections are one of the methods employed to attach overlapping steel piles. The joints are in-situ achieved employing ultra-high performance cementitious grouts, however their installation can be affected by challenging weather conditions. Even during ideal weather conditions, environmental loads acting on the structure induce movements between the steel piles due to lack of stiffness provided by the grout during the first hours of curing. Such movements can impact the long term performance of the joint significantly. These phenomenon is not explicitly addressed by current design codified approaches, although it severely affects the installation of offshore wind structures.

This project aims to investigate the performance of ultra-high performance grouts during the first hours of curing and to provide a novel methodology to account for this phenomenon. The project will comprise experimental testing and numerical modelling to investigate several parameters influencing the performance of the grout at early stages and ultimately develop an analytical approach to account for early age performance of grouted connections.

Knowledge and skills required in applicant:
The successful applicant should have been awarded, or expect to achieve, a Master's degree in a relevant subject and/or a First or Upper Second Class Honours degree (or an equivalent qualification from an overseas institution) in [Civil Engineering, Mechanical Engineering or similar]. Preferred skill requirements include knowledge/experience with Finite element analysis, experience with laboratory testing and previous experience with offshore structures.

2022-2023_037 - Emergent Behaviour in Complex Systems - Social Unrest Predicted through Behavioural Modelling (SCAM)

Supervisor: Dr Amit Chattopadhyay (School of Digital Engineering; Mathematics Department / Aston Institute of Urban Technology and the Environment - ASTUTE / Neural Computing Research Group)
Assoc. Supervisor: Dr Juan Neirotti (School of Digital Engineering; Mathematics Department / Aston Institute of Urban Technology and the Environment - ASTUTE / Neural Computing Research Group)
Assoc. Supervisor: Professor Siddhartha Bandyopadhyay (University of Birmingham, Economics Department)

Area of Research: Interdisciplinary science, combining applied mathematics and social science modelling – Smart City ASTUTE

Techniques – Statistical Mechanics, Opinion dynamics, Machine Learning, Statistical data modelling
Project Summary, Aim and Objectives:
Summary
This interdisciplinary project, supervised by a mathematical modeller (Chattopadhyay), machine learning specialist (Neirotti) and social scientist (Bandyopadhyay), will analyse the origin of civic unrest in an open democratic society combining Mathematics (M) with Machine Learning (ML). The M-ML toolset will model how individual belief patterns nucleate into collective extreme mindsets e.g. peer effects engineering

beliefs that certain crimes are stigma-free. Established Opinion Dynamics Models (ODMs) will be refined through incorporation of public 'fickleness' as 'stochasticity', and then parameterised by *ML* to predict the onset of specific criminality forms by analysing *spatial level crime data*.

Key Research Questions (RQs) for the PhD student:
To understand if the evolution of extremist belief pockets could be mitigated over time by tuning appropriate 'social pressure' modes, the student would address
RQ1 - model behavioural trends (e.g. ideology, priors, contrarians etc) of interacting agents using stochastic-ODMs,
RQ2 – analyse spatial crime data using ML to parameterise RQ1-model to determine how 'individual' belief patterns leads to specific criminality forms,
RQ3 – generalise RQ2-model with public fickleness to model inter-relationships between affecting social factors (e.g. crime record, age, gender, location etc).

Methodology
Interactive belief systems are inherently complex that are further complicated by a) over-reliance on opinion differences, disregarding individual opinion thresholds; b) lack of adaptive learning strategy; c) their impact on global social unrest.
SCAM will address (a-c) through ODMs, public 'fickleness' through stochastic-ODMs, thereby delivering criminality specific models by extracting information from spatial crime data using ML.

Key deliverable:
The SCAM project will deliver a belief-tracking algorithm to analyse public interaction patterns using probabilistic modelling, that is parameterised against crime data using ML, to predict social instabilities and insurgency. As the Director of 'Crime, Justice and Policing Institute' in UoB, Bandyopadhyay will liaise with Midlands Police to discuss implementation of the SCAM-model towards Midlands' safe keeping.

Knowledge and skills required in applicant:
Required: Basic knowledge of probabilistic mathematics and computer programming skills (any language); some experience of numerically analysing differential equations

Preferred: Knowledge of elementary machine learning (visual informatics, dimensional reduction) and some statistical data modelling skills

Training to be offered on: Stochastic mathematics; Probabilistic modelling; Machine Learning

2022-2023_038 - Development of Novel Enabling Solutions for the Probabilistic Control Cf Quantum Systems

Supervisor: Dr Randa Herzallah (School of Digital Engineering; Mathematics Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Roberto Alamino (School of Digital Engineering; Mathematics Department / Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Engineering and physical sciences, mathematical modelling, data analysis and machine learning.

Project Summary, Aim and Objectives: This project will explore new ways of using external signals to actively influence and manipulate the evolving state of quantum systems at the level of atoms, molecules

and particles. By accurately controlling the interactions between the quantum components of the system, experimentalists will be able to evolve the system towards some desired outcome and create new quantum states that can be used for tests of fundamental physics and quantum technological applications. A general framework where randomised explorative control methods that counteract the decoherence, and uncertainty characterising a quantum system will be sought. The framework will be based on the estimation of the complete information of a quantum system through the characterisation of the probabilistic descriptions of the involved variables. Randomised controllers that can characterise and take into consideration the uncertain and incomplete information of a quantum system will then be designed.

These aims are supported by the following objectives:
Objective 1: Develop a control theory based on the characterisation of the probabilistic description of a many-body quantum system, which involves:
- A fully probabilistic control framework for designing coherent randomised controllers that preserve the unitary transformation of a quantum system.
- Design incoherent randomised controllers for many-body systems where unitary transformation cannot be achieved.
Objective 2: Develop probabilistic models that can reproduce the stochastic dynamics of a quantum system.
Objective 3: Generalise the design of the randomised controllers to switching quantum dynamics.
Objective 4: Develop randomised controllers for dynamics with state and control input delays.

Knowledge and skills required in applicant:
Candidates should have, or be about to achieve, a degree in control theory, electrical/electronic engineering, mechanical/mechatronics engineering or other relevant area. Candidate with suitable work experience and strong capacity in mathematical modelling and control are particularly welcome to apply.

2022-2023_039 - Malware Detection and Classification Technique using Quantum Search

Supervisor: Nitin Naik (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Paul Grace (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Igor Yurkevich (School of Digital Engineering; Mathematics Department)

Area of Research: Cybersecurity and Quantum Physics

Project Summary, Aim and Objectives: The volume of malware and number of attacks are increasing on a daily basis, which challenges security experts to continuously develop more effective techniques for malware detection and classification. Consequently, a malware detection and classification technique based on super-fast computation and search operation is an inevitable need of this malware detection process, otherwise the effectiveness of any malware detection and classification technique will be outweighed by the performance issue due to this ever-increasing volume of malware. This leads to the exploration of quantum computation and quantum search algorithms to evaluate their performance with classical operation and adapt them for malware detection and classification, which is still not looked at by cybersecurity experts as a practical viable solution. Therefore, this project will examine this viability and aim to develop a quantum technique for malware detection and classification and achieve the following objectives:

1. This project will evaluate some of the most popular quantum search algorithms and compare their performance with classical search algorithms.

2. Based on the comparative analysis of quantum search algorithms, this project will adapt the most effective quantum search algorithm(s) with some other malware detection and classification mechanisms to make it suitable for malware detection at scale.
3. Subsequently, the proposed malware detection and classification technique will be applied to the available dataset to evaluate its performance.
4. Finally, developing this malware detection and classification technique as a user-friendly and commercial tool for everyone to use for malware detection.

Knowledge and skills required in applicant:
Computer Science /Physics/Cybersecurity Degree
Good knowledge of quantum programming,
Good knowledge of programming languages,
Basic Knowledge of AI techniques.

2022-2023_040 - Implementation of Machine-Learning to Optimize the Li-ion Batteries (LiB) Remanufacturing Process

Supervisor: Muftooh Siddiqi (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Professor Yuchun Xu (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Area of Research: remanufacturing, machine learning, energy storage, Industry 4.0, Circular Economy and WEEE.

Project Summary, Aim and Objectives: Li-ion batteries (LiB) used in electrical vehicles typically have 10-20years of life, they normally cannot be used when their performance decrease to 80% of original designed capacity for Electric Vehicles (EV). With the increase of EV uptake, there will be more and more (estimated at millions of tons) LiB waste, which is going to be a big problem to solve in the imminent future.

Remanufacturing, as one End of Life (EoL) strategy in Circular Economy, can be potentially used to tackle this problem. Currently the remanufacturing of LiB is not widely and well practiced due to the inefficiency and high cost associated with remanufacturing process. The current remanufacturing process needs to be optimised to increase the efficiency and reduce the cost.

This project aims to optimise quality evaluation, which is second step in remanufacturing process to decrease time and cost by developing a machine learning model for the input technical parameters of a battery (Energy Storage Over Energy ESOEI, battery storage capacity and operational temperature etc.). The project has the following objectives

Objectives:
O1. Develop a sustainable, impactful, optimized and novel machine-learning model for quality evaluation based on technical parameters (ESOEI, battery storage capacity and operational temperature etc.), to reduce time and cost for the remanufacturing of high-quality LiB.

Methodology/research tasks:
T1.1 Develop a testing rig for remanufacturing of LiB and acquire technical parameters such as Energy Storage Over Energy Invested, battery storage capacity and operational temperature etc.

T1.2 Develop a machine-learning model for stored parameters to 'predict battery life and quality with a single parameter'. (Model will save time and cost by making decision based on a 'single parameter within seconds', instead of multiple parameters within hours.)

Impact:
3 hours saved per remanufacturing process.
Saving approximately 60% over new battery use.
Cost saving up to GBP50 per KWh.

Knowledge and skills required in applicant:
Applicants should have, or expect to achieve, a first-class Honours degree (or equivalent) in Mechanical, Industrial, Manufacturing, Electrical Engineering, Machine-Learning or a related subject. A relevant Master's degree and/or experience in one or more of the following will be an advantage: Sustainable Manufacturing; Machine Learning, Remanufacturing; Circular Economy.

2022-2023_041 - Network-Aware Architecture for Multi Unmanned Aerial Vehicle

Supervisor: Dr Alexandros Giagkos (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Paul Grace (School of Digital Engineering; Computer Science Department)

Area of Research: Multiple Unmanned Aerial Vehicles, Autonomous Control, Swarm Robotics, Communication Networks

Project Summary, Aim and Objectives: From surveying and mapping missions to search and rescue operations, employing a group of autonomous unmanned aerial vehicles (UAVs) provides tremendous advantages compared to a single vehicle, such as flexibility, fault tolerance, simultaneous actions, etc. The UAVs are expected to connect to and maintain an ad-hoc aerial network while autonomously controlling their flying to meet their goals. The resulting network needs to be self-organised and allow for optimal data exchange between all members of the group and any connected ground-based users (or vehicles). Maintaining such networks can only be achieved by employing flying controllers, which, apart from the sensor and motor capabilities of the aerial vehicles, use the input from the underlying communication links.

Building on our team's previous work, this PhD will employ genetic algorithms to control multiple UAVs autonomously in missions where flying formation depends on communicating users on the ground. To tackle the challenge mentioned above, we will investigate approaches to collect and analyse real-time data related to network qualities and communication parameters, including those derived from QoS-related demands. Subsequently, the data will be utilised by the multi-UAV control algorithms designed to deliver optimal flying solutions. To avoid network overheads, we will exploit cross-layering and the integration of low-level network protocols for the data collection with the multi-UAV controller.

This PhD will develop a novel network-aware architecture capable of autonomously flying multiple UAVs that form optimised networks for missions where ad hoc and autonomous deployment is deemed necessary. The expected research outcomes include papers submitted to top soft computing and network-related international conferences and journals.

The successful applicant will join a diverse team of academic researchers with expertise in network engineering, artificial intelligence and UAV flying and control and will have the opportunities to travel and participate in flying trials for data collection and platform testing.

Knowledge and skills required in applicant:
Competitive applicants will have a first-class or upper second-class degree (or equivalent) in relevant subjects including computer science, artificial intelligence or engineering.

2022-2023_042 – Minimum Infrastructure Internet of Things (IoT) Sensor Networks for Air Quality Monitoring

Supervisor: Dr Richard Nock (School of Digital Engineering; Electrical and Electronic Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Lucy Bastin (School of Digital Engineering; Computer Science Department / Systems Analytics Research Institute)
Assoc. Supervisor: Professor Kate Sugden (School of Digital Engineering; Electrical and Electronic Engineering Department / Aston Institute of Photonic Technologies - AiPT)

Area of Research: Smart city technologies, Internet of Things/wireless sensors for environmental sensing.

Project Summary, Aim and Objectives: Ambient Air Pollution (AAP) is becoming an increasing problem not only for climate change, but for human health as well. The World Health Organisation (WHO) estimates that 90% of people are breathing polluted air and that 7 million people die each year due to particulates entering the lungs and cardiovascular system. AAP is of particular concern in Asia and Africa, but many city centres in the UK also often suffer from particulate concentrations which exceed WHO recommended levels.

Currently, a network of sparse monitoring stations is utilised to monitor values hourly. In Birmingham, there are typically 4 monitoring stations, which provides poor spatial resolution to identify problematic areas. In addition, widespread installation of such stations is limited by cost. This project will investigate the deployment of wireless sensor nodes containing readily available low-cost sensors to sense the key components of AAP (PM2.5 amongst others). To reduce infrastructure requirements, LoRA mesh technologies will be investigated to reduce communication infrastructure costs, necessitating only a singular gateway in each city. In addition to this, energy harvesting and power reduction techniques will be investigated to ensure nodes can operate for as long as possible.

This work will be undertaken in the ASTUTE research institute and to trial this technique, it is envisaged that a small-scale demonstration system will be installed around the campus at Aston University to monitor AAP air quality values. In addition, wireless sensor nodes will be placed around the inside of the main building to monitor indoor air quality.

This system will be used to evaluate the performance of mesh sensor networks in real-life conditions. This approach will bring the highest data rate and spatial resolution possible to air quality monitoring, demonstrating smart city technologies and paving the way towards Aston being a green campus.

Knowledge and skills required in applicant:
Hands-on experience of embedded systems, electronic design (schematic and PCB design) and software engineering are advantageous. This project will require strong problem-solving skills and enthusiasm to solve challenging technical problems. The candidate should preferably have an electronic engineering degree or a degree in a similarly numerical discipline.

2022-2023_043 – Design for Change: Utility as Desire in a New-Luxury Era

Supervisor: Dr Timothy Whitehead (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Lyndon Buck (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)

Area of Research: Design for a Sustainable Future, Design Practice, Design Thinking, Design Research.

Project Summary, Aim and Objectives: The definition of luxury design is changing, with millennials and Generation Z increasingly seeing the traditional concept of luxury product design as negative, extravagant, and overrated (Fabrik, 2021). During the pandemic people have become more environmentally aware of the products and services they buy. The PWC Global Consumer Insight survey (2021) found that half of all global consumers say they have become more eco-friendly and many wish to make significant changes to the products, services and environments they live in. This has resulted in a need to create ethical products which re-define the concept of luxury and enable consumers to make ethical and responsible decisions.

Therefore, this project seeks to develop an understanding of ethical design decision making and propose ways in which the product industry can respond to pressing environmental concerns. It is expected that this project will challenge current design practice and advocate change with a focus on exploring how utility design can be made desirable and luxurious.

Aim: To investigate ethical design decision making in a new-luxury era and propose ways to respond to pressing environmental concerns.

Objectives:
- Establish current design practice and ethical decision-making tools for consumer products
- Develop an approach to reduce consumption and explore the approaches to luxury utility design
- Use practice-based design research to test and develop the approach
- Validate the approach though product case-studies and practical outputs.

Knowledge and skills required in applicant:
We are looking for motivated and engaged individuals who have experience in design practice, design thinking and are keen on ethical design practice to become a part of the product design team. Applicants should be educated to masters level, or equivalent, in Product Design, Industrial Design, Design Engineering, Architecture or similar design field.

2022-2023_044 - Human Visual Perception with Helical Wave Fronts and Various Optical States

Supervisor: Professor Igor Meglinski (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Professor Stephen Anderson (College of Health & Life Sciences / Centre for Vision and Hearing Research / Optometry & Vision Science Research Group)
Assoc. Supervisor: Professor Gary Misson South Warwickshire NHS Foundation Trust, College of Health & Life Sciences / Centre for Vision and Hearing Research / Optometry & Vision Science Research Group)

Area of Research: Ophthalmology, Ophthalmology/Optometry, laser light, polarization, shaped light with Orbital Angular Momentum (OAM), photonics, imaging.

Project Summary, Aim and Objectives: The overall goal of the project is to investigate human visual perception of structured light with helical wave fronts, and explore their applicability for detecting central visual field dysfunctions, including age-related macular degeneration and diabetic retinopathy, in routine clinical practice.
Biomedical applications of complex structured light with helical wave front/OAM have not been explored in any detail so far. Background theoretical and experimental studies on sensitivity of structured light with OAM to the small alterations in biotissues do not exist. Therefore, the project represents a major breakthrough, one that will define new physical phenomena, such as interaction of OAM/helical wave front with biological tissues, to detect small static and dynamic alterations of their optical and structural properties, which serve as the actual markers of certain dysfunctions. The techniques could provide a basis for the rapid, objective and accurate assessment of macular function in health and disease.
The imaging approach developed promises to be highly targeted, and may revolutionise clinical diagnosis of visual dysfunction in common and dangerous macular diseases (such as including age-related macular degeneration and diabetic retinopathy), with sensitivity far beyond the standard limitations and resolution currently achievable in clinical practice. The project will be linked with clinicians from South Warwickshire NHS foundation Trust.

Knowledge and skills required in applicant:
Preferable candidate needs to have knowledge of optics, polarization, basic knowledge of Matlab, programming skills, basic experimental skills, understanding of light-tissue interaction and an experience in 3D printing and material research.

2022-2023_045 - The Impact of Ocular Morphology on Aqueous Humour Flow Parameters – A Computational Fluid Dynamics (CFD) Study

Supervisor: Dr Patrick Geoghegan (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Tabbi Awotwe (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Antonio Fratini (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)

Area of Research: Engineering, Mechanical Engineering, Ocular Disease, Glaucoma, Fluid Dynamics, Biofluids,
Computational Fluid Dynamics

Project Summary, Aim and Objectives:
Aim
In vitro, characterisation of the effect Schlemm's Canal dimensions has on ocular fluid dynamics using CFD.

Hypothesis
Geometric changes can drastically alter the fluid flow field in the anterior chamber, directly affecting physiologically important parameters.

The number of people (aged 40-80 years) with glaucoma worldwide was estimated to be 76.0 million in 2020 and to increase to 111.8 million in 2040. At the same time the number of individuals with myopia and high myopia is increasing worldwide. Any level of myopia has been associated with an increased risk of developing glaucoma, which makes it a ticking time bomb considering the increased life expectancy and the fact that age is the major risk factor for glaucoma. In both glaucomatous and myopic eyes Canal of Schlemm's dimension have been found to be larger than in normal length eyes, which may help explain the increased risk of myopes developing glaucoma. However how geometry is linked with aqueous humour flow parameters is not known. Understanding the mechanisms will not only help guide surgical procedures in patients with glaucoma to improve surgical outcomes but will also help understand the physiological changes leading to fluid dynamic alterations and how shear stress alterations contribute to cellular damage and loss of function. CFD provides the perfect tool to achieve this goal. Using physiologically realistic models obtained from OCT scans, it will be possible to study in-vitro, the fluid dynamic affects that can be caused by the Canal of Schlemm variation.

Objectives
Development of a database of physiological models to be used in computational studies of ocular diseases

Parametric CFD study of geometric variation in the Canal of Schlemm in an idealised model of the eye

CFD study in Physiologically realistic geometries. Comparing healthy emmetropes and highly myopic patients, elucidating on the connection between fluid dynamics and the degeneration in health.

Knowledge and skills required in applicant:
The successful applicant should have a first class or upper second class honours degree in Biomedical Engineering, Mechanical Engineering, Aeronautical Engineering or a related subject. Preferred skill requirements include knowledge/experience of fluid mechanics / Computational Fluid Dynamics / CAD / basic programming e.g. MATLAB.

2022-2023_046 – Artificial Intelligence (AI)-Driven Virtual Training Buddy

Supervisor: Dr Ulysses Bernardet (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Aniko Ekárt (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Artificial Intelligence; Human-Computer Interaction; Virtual Humans; Sports Science

Project Summary, Aim and Objectives: Remote virtual fitness training has recently seen a massive boom with the exercise equipment and media company Peloton (2.33 million subscribers, quarterly revenue $937 million) leading the way. This trend is very welcome not only because more people are engaging in physical activity, but also because of the sustainability of remote training.

However, the interaction with coaches and training buddies still heavily relies on direct human intervention limiting the affordability and customizability of the fitness training.

The proposed project researches the development of an artificially intelligent, autonomous virtual training buddy that has the ability to communicate verbally and non-verbally with the user as well as to demonstrate exercises to the user.

The main goal of the personalised human-like agent is to increase training motivation and ultimately training adherence. The virtual training buddy will establish initial rapport with the user, set goals and motivation in pre-training, guide the user during the training session, and provide post-training feedback.

The HCI research questions include what communication method and style (verbally and non-verbally) is the most effective to maximise the users' intrinsic and extrinsic training motivation. On the AI side, we will investigate Machine Learning and Data Analytics methods for the optimal intervention timing and method. This project is planned in collaboration with an global, world-leading industrial partner in the fitness-related sector.

Knowledge and skills required in applicant:
Required: Background in computer science with a strong interest in HCI and AI
Desired: VR/game development; machine learning/data analysis; experimental design;

2022-2023_047 - Sustainable Low Carbon Fuels for Marine Engines Application

Supervisor: Dr Abul Kalam Hossain (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department, Aston Institute of Urban Technology and the Environment / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Tabbi Awotwe (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Jose Ricardo Sodre (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department, Aston Institute of Urban Technology and the Environment – ASTUTE / Energy & Bioproducts Research Institute - EBRI)

Area of Research: Sustainable Energy and Transport

Project Summary, Aim and Objectives: Carbon emissions from Marine Engines causing negative impacts on the environment and living beings. It is forecasted that the emissions from marine sectors would rise three folds by 2050. Worldwide, stringent emissions norms and net zero targets putting pressures on the marine sectors for replacement of heavy marine crude oils with sustainable and renewable alternative fuels. Use of sustainable low carbon fuels would help to reduce the carbon emissions in the marine sectors. In this PhD project, a critical review on the various low carbon sustainable fuel technologies for marine engines will be carried out. A lifecycle energy and emission analysis will be carried out for various options. The project would involve development of novel approaches of decarbonising the marine engines. The technologies investigated would be - (i) Combustion of NH3 as a green fuel in the marine engines. The NH3 combustion strategies will be developed using either a duel fuel or dual injection strategy. Various promoter as a second fuel for NH3 combustion will be investigated and modelled. Engine experiments will be carried out to assess the emission savings using novel low temperature combustion strategies such as HCCI and RCCI techniques, (ii) Use of sustainable biofuels especially biodiesels produced from waste resources (2nd generation) and algae (3rd generation) as drop in fuels for marine engines. According to EU Renewable Energy Directive, biofuels must achieve 35% GHG savings. The fuel quality of biodiesels and emission savings depends on feedstock type and conversion parameters; often biodiesels produced from single feedstock does not meet the EN14214 biodiesel standard. Biodiesels produced from various resources will be mixed together to produce ‘biomix’ fuels to meet the biodiesel standard.

Knowledge and skills required in applicant:
01. Bachelor Degree in Mechanical or Chemical Engineering
02. Very good analytical and problem solving skills

03. Good background on engines and low carbon fuels
04. Ability to work in a multi-disciplinary environment

2022-2023_048 - Human Activity Analysis In Smart Environments

Supervisor: Dr Luis J. Manso (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and Environment - ASTUTE)
Assoc. Supervisor: Professor Jo Lumsden (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and Environment - ASTUTE)
Assoc. Supervisor: Dr George Vogiatzis (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and Environment - ASTUTE)

Area of Research: Assisted Living, Machine Learning, Artificial Intelligence

Project Summary, Aim and Objectives: Analysing human activity has a wide variety of applications, including but not limited to human-robot interaction, security and assisted living. Although limited by some technological, economical, ethical and privacy constraints, the impact of these applications is no longer a promise for the future, but a reality. Chairs and glasses are currently being used to monitor older people's safety to promote healthy independent living with simple sensors such as fall detectors. Autonomous cars and robots analyse pedestrian behaviour to assess risk and comfort. The main goal of the project will be to analyse behaviour based on vision sensors that allow for non-invasive analysis.

When considering vision-based data acquisition methods, non-invasiveness, accuracy and privacy form a triangle where one corner is sacrificed. Methods based on markers or wearables are accurate and only gather the necessary data, but are invasive. Non-invasive methods are either of limited accuracy or prone to generate serious privacy concerns. Processing the acquired data has similar limitations in terms of accuracy, privacy and response time. The aim of the PhD will be to remove or mitigate to the greatest possible extent these limitations. The student will design and develop models to implement data acquisition and activity analysis, and evaluate how these models perform considering accuracy, response time, privacy and non-invasiveness.

Knowledge and skills required in applicant:
First class or upper second-class honours degree or equivalent qualification in Computer Science, Mathematics, Electronics, Physics, Statistics or related areas. The applicant should have demonstrable skills on programming and machine learning.

2022-2023_049 - Production and Modification of Biochar for Soil Amendment

Supervisor: Dr Daniel J. Nowakowski (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute – EBRI)
Assoc. Supervisor: Dr Jiawei Wang (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department)
Assoc. Supervisor: Professor Tony Bridgwater (Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Tim Miller (Energy and Bioproducts Research Institute - EBRI)

Area of Research: Chemical Engineering; Applied Chemistry; Reaction Engineering; Material Science

Project Summary, Aim and Objectives: Biochar is a carbon-rich material that can be prepared by thermal treatment (slow or intermediate pyrolysis) of various organic waste feedstock, such as agricultural waste and municipal sewage sludge. Biochar has received increasing attention due to its unique features for soil fertility improvement (to increase soil carbon stocks and reduce greenhouse gas emissions). Biochars' physical and chemical properties and their final application are strongly related to the type and biochemical composition of the initial biomass material used in the pyrolysis processing (at tailored process conditions) and physicochemical modifications.

This PhD research project aims to optimise the physicochemical characteristics of biochar by investigating different processing conditions and types of biomass/organic waste used as pyrolysis feedstock and modification of produced biochars for testing as soil improvers.

The main research tasks of this PhD project will include:

- Characterisation of waste and biomass feedstock (applying different analytical techniques including elemental analysis, analytical pyrolysis, and thermogravimetric analysis).
- Production of biochar using EBRI's mobile pyrolysis unit (Cofton Nursery, Birmingham) at various processing conditions.
- Characterisation of pyrolysis products with a focus on biochar properties (chemical composition, morphology, surface analysis, water/nutrients retention).
- Modification and testing of produced chars towards their application as soil improvers (nutrients and water remediation agents).

This PhD research project will be based in the Energy and Bioproducts Research Institute (EBRI) and associated with the ongoing Biochar Urban Project coordinated by EBRI in partnership with the Birmingham City Council and companies from the West Midlands region. The successful candidate will have access to state-of-the-art processing and analytical laboratories and receive professional support from EBRI's interdisciplinary experts. Soft skills and professional trainings will be provided via the Aston University Graduate School, Supergen SHARE and Energy Research Accelerator (ERA) networks.

Knowledge and skills required in applicant:
Essential: First-Class or Upper Second-Class UK honours degree (or international equivalent) in Chemical Engineering or Applied Chemistry.

Desired: Knowledge of thermal processes (particularly pyrolysis), Aspen software and characterisation of carbonaceous materials.

2022-2023_050 - Augmented Reality Agent for Citizen Wellbeing

Supervisor: Dr Christopher Buckingham (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Dr Ulysses Bernardet (School of Digital Engineering; Computer Science Department / Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Artificial Intelligence; Decision support system; Human-Computer Interaction; Virtual Humans; Augmented Reality; Wellbeing, Mental Health

Project Summary, Aim and Objectives: The aim of the project is to contribute to the development of an Augmented Reality agent that supports the wellbeing of citizens. Wearing holographic glasses, users will

be able to interact with the human-like Augmented Reality agent as if it was part of the physical environment. The agent will support citizens through a number of capabilities ranging from giving directions, to being a chaperone, to supporting users when confronted with mental health issues. Mental ill health is a growing public concern and incurs economic costs of billions every year. Recently, social isolation during the covid-19 pandemic has exacerbated these issues for many citizens.
Importantly, the agent will proactively initiate interactions with the user and show empathic responses -- facial expressions, posture, and non-verbal behaviour (nodding, posture) -- to the content, context, and affective quality of the user's communication. When appropriate the agent will guide the user to resources of further help.
The expert knowledge-based GRiST mental health decision support system (Buckingham et al., 2015) will serve as the backend for prompting users about their wellbeing and assessing the wellbeing state.
The project will investigate the AI capabilities required for the agent to identify meaningful interventions as well as how rapport is established and how the agent can function as an empathic and non-judgemental lister.
While agents in Virtual Reality have been shown to be effective in health interventions, Augmented Reality agents have not been investigated so far. Augmented Reality is an emerging technology that will become an important part of daily life in the near future. Agents operating within Augmented Reality are an exciting new research domain that holds enormous potential but with little empirical evidence.

Knowledge and skills required in applicant:
Background in computer science/engineering with a strong interest in psychological modelling.
Skills: VR/AR development (Unity); machine learning; experimental design; data analysis.

2022-2023_051 - Bioremediation of Elastane within the Textile Industry

Supervisor: Dr Alfred Fernandez-Castane (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Energy and Bioproducts Research Institute - EBRI)
Assoc. Supervisor: Dr Alan Goddard (College of Health and Life Sciences, School of Biosciences / Biosciences Research Group)
Assoc. Supervisor: Rachel Webley / Tom O'Haire (Gymashark Ltd.)

Area of Research: Enzyme catalysis, microbiology, polymer chemistry and analytical biochemistry; toward a sustainable and circular textile economy

Project Summary, Aim and Objectives: One of the largest applications of synthetic polymers correspond to their use in textiles. In 2017 the textile global market size surpassed 103 million tons (Mt), out of which 63 % constituted petroleum-based virgin fibers [1]. Most waste textiles are currently being incinerated or disposed into landfills, thus having undesired impact in our environment. The increasing use of synthetic fibers means that the accumulation of difficult-to-recycle blended materials is rapidly growing and this requires urgent action. Reaching a circular textile economy [2] requires for example, the recovery of individual components from complex polymer blends, to enable regeneration of fibers with the same properties as the respective starting materials [3]. However, this task is challenging due to the complexity of textile materials. The project, in collaboration with a global brand from the leisure industry, will investigate the application of enzyme catalysis toward the de-polymerisation and recycling of textile plastics.
The project will involve:
1. Designing and testing of recombinant bacteria producing elastane-degrading enzymes for the breakdown of different types of textiles. Analytical methods such as HPLC and LC-MS will be used to

detect the release of low molecular weight products, TGA/DSC will be used to analyse changes in polymer thermal properties, and changes in microscopic structure will be studied by SEM and TEM.
2. Investigating chemical and thermal pre-treatment strategies to enable high biocatalytic activity facilitating de-polymerisation.
3. Studying the mechanism of de-polymerisation, using kinetic analysis, and probing reaction intermediates.
4.Optimizing conversion yields via testing of different biotransformation conditions. Applications for products of the biotransformation will be explored.

References:
[1] A. Carmichael. Man-Made Fibers Continue To Grow. Textile World Innovation Forum. 2015. Textile Industries Media Group, LLC.
[2] Ellen MacArthur Foundation. A new textiles economy: redesigning fashion's future. 2017. http://www.ellenmacarthurfoundation.org/publi-cations.
[3] ChemSusChem 2021, 14, 4028-4040

Knowledge and skills required in applicant:
Applicants should have experience in biochemistry or chemical biology or microbiology. Experience of working with enzymes would be valuable.

2022-2023_052 - How Can Curricula and Learning within Engineering Degree Programmes Be Developed to Support Regional Innovation and Growth?

Supervisor: Dr Gareth Thomson (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department)
Assoc. Supervisor: Dr Lucy Rackliff (School of Infrastructure and Sustainable Engineering; Engineering Systems and Supply Chain Management Department)
Assoc. Supervisor: Rebecca Broadbent (School of Engineering and Technology; Aston Foundation Centre Department)

Area of Research: Engineering for Society, Engineering Pedagogy, Skills Development, Capacity Building

Project Summary, Aim and Objectives: The societal impact of Universities is often framed around the development of high profile technical innovations or alternatively, the value is purely defined by the economic impact of a large employer and large student spend base within a city.

It has to be argued however that the greatest impact of most Universities, is the quality and potential of the graduates they produce. These will be the individuals who will support growth and innovation in the SMEs, start-ups, nationals and multi-nationals through their working life. Ensuring they are fully equipped to do so, should be the goal of all progressive educators.

The aim of this work will be to determine where gaps exist in the educational provision which prevent engineering graduates from maximising their subsequent impact in the workplace and develop educational interventions to close or eliminate key weaknesses.

The project will involve working closely with a wide range of stakeholders including industry, business organisations, students, alumni and academics to identify key opportunities to develop interventions which can have maximum bearing in increasing the impact engineering graduates have in stimulating innovation within regions.

Best practice, regionally, nationally and internationally will be explored and appropriate educational interventions developed and trialled with the aim of developing a route map or toolkit to help create a step change in the capacity of engineering graduates to support innovation and growth.

Knowledge and skills required in applicant:
The project would suit an individual with a passion for the role education has to transform not only the growth of individuals but society in general.
Applicants are likely to have a STEM, Social Science or Education first degree with teaching in HE a likely part of a planned career.

2022-2023_053 – Digital Twin Based Life Extension of High Value Engineering Asset for Circular Economy

Supervisor: Dr Yuchun Xu (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and Environment - ASTUTE)
Assoc. Supervisor: To be confirmed

Area of Research: Circular Economy, Sustainable Manufacturing, Smart manufacturing, Digital Engineering, Robots, Data analytics, Machine learning, Artificial Intelligence, Computer Science, Applied Mathematics

Project Summary, Aim and Objectives: Circular Economy is an important mode to ensure sustainable and resilient development of industry and society One of the aspects of Circular Economy is to promote the reuse and life extension of various products and equipment to reduce the demands to new resources; On the other hand, high value engineering asset (such as machine tools, robots, and wind turbines) is important to the operation and service provision in industry, it is important to ensure/increase their availability to avoid/minimise disruption of operation and services they provide, which requires proper maintenance to extend the life of these engineering asset.

Life extension of engineering asset can be facilitated by the state-of-the-art digital technologies, e.g. through the application of digital twins to monitor the condition of asset, predict their remaining useful life, and plan optimised maintenance activities.

This project aims to develop digital twin model for high value engineering asset to extend their life. The work include specific objectives and development of (1) condition monitoring techniques (such as vibration and acoustic emission analysis based methods) for failure detection and identification (2) data driven approach for remaining useful life prediction (3) mathematical approach for planning and optimisation of maintenance activities by taking into account real operation scenarios.

Knowledge and skills required in applicant:
The applicant should have the background in Mechanical Engineering, Mechatronics, Electronics and Computer Science. Desired knowledge and skills include Failure modes/mechanism of mechanical and mechatronic system; Data analytics, machine learning and their applications; Mathematical algorithm development for engineering applications; and Software programming.

2022-2023_054 - Vulnerable Transport Modes – Modelling the Behaviour and Health Impacts of Pedestrians, Cyclists and Micromobility Users.

Supervisor: Dr Lucy Bastin (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Maria Chli (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr George Vogiatzis (School of Digital Engineering; Computer Science Department)

Area of Research: Multi-agent systems, Computer Vision, Machine Learning, GIS, Air Quality

Project Summary, Aim and Objectives: Currently, data on vulnerable road user groups (pedestrians, cyclists, etc.) is infrequently collected, poorly described, and rarely analysed. A growing proportion of road users around the globe are travelling by active modes or using micromobility solutions like eScooters, particularly in cities. It is increasingly important to measure, monitor and model the use of these vulnerable modes and evaluate their implications for safety, network priority, air quality and sustainability. In this project you will work with market-leading road safety analysts and a team of experienced academic researchers to build a detailed model of vulnerable road user behaviour. You will use CCTV footage to calibrate and validate models of these users' real world behaviour and build innovative models to predict the impacts of mobility choices on the individual and on the urban system as a whole. You will use air quality data from a range of existing sources (satellites, DEFRA monitoring stations and citizen science /low-cost sensors) to evaluate the accuracy and assumptions of pollution models.

The PhD project will use these models to look at specific questions related to real world road use:

- Calculating pollution exposure rates for pedestrians, cyclists and micromobility users
- Characterising pedestrian behaviour – incursion to road, use of crossing, erratic behaviour
- Micromobility behaviour – are eScooter riders adhering to speed limits (advisory or statutory), are they using mobile phones, are helmets in use, is road position legal, are sidewalks in use?
- Automation of traffic control of complex junctions, to ensure safety, optimal throughput
- Prediction of the properties of traffic junction designs before they are actually deployed.
- Do we have to make trade-offs between efficient traffic flow and air quality, or can both be achieved?

Knowledge and skills required in applicant:
Familiarity with Python and ideally a Neural Network framework (pytorch/tensorflow). Good analytical/maths skills. Some experience with image/video processing would be advantageous. Enthusiasm to learn about spatial data and air quality models will be very helpful.

2022-2023_055 – Developing a Collaborative Tool for the Integration of Lean Construction (LC) and Building Information Modelling (BIM) Teams at Construction Companies

Supervisor: Dr Algan Tezel (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)
Assoc. Supervisor: Dr Tala Kasim (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)

Area of Research: Building Information Modelling, Lean Construction, Digital Technologies, Construction and Engineering Management, Built Environment.

Project Summary, Aim and Objectives: The construction industry has long been subject to criticism for its poor performance. Lean Construction (LC) and Building Information Modelling (BIM) are two of the most prominent concepts adopted by the construction industry to improve project delivery performance. LC is a complex cocktail of project management principles and tools which takes its roots from the car manufacturing industry. BIM refers to the technologies and processes enabling an effective management of project information from conception to demolition. There are significant positive synergies in the combined implementation of LC and BIM. However, these two concepts are often led and implemented by different teams at client, design, and construction organisations in silos. This is mostly due to a lack of awareness and wrong prejudices present in the LC and BIM teams. Creating collaboration between the LC and BIM teams is critical for BIM to facilitate LC principles/tools and for LC to improve BIM processes to make the most of the synergy between these two concepts. This is also a major concern in the industry on a global scale.

The aim of the proposed project is to develop a collaborative digital tool supporting the integration of BIM and LC teams in the construction industry. The proposed project will consist of these objectives:

O1: Understanding the collaboration dynamics between different teams from the literature.
O2: Mapping and recording the two-way synergy between LC and BIM in design, construction and facilities management from the literature and workshops/interviews.
O3. Understanding the requirements for a digital, interactive, collaborative tool (on the cloud, mobile etc) which will help the LC teams understand how BIM can facilitate LC principles/tools and the BIM teams understand how LC can improve their processes through project life-cycle. The tool can be labelled as a "LC and BIM translator" for the awareness and training of construction professionals and Built Environment/Civil Engineering students.
O4. Developing and testing of the digital tool (proof-of-concept) with industry practitioners.

Knowledge and skills required in applicant:
1. Knowledge of construction/engineering management, digital construction, LC and BIM
2. Knowledge of or willingness to learn modern user interface design, web and cloud-based technologies

2022-2023_056 - Photorealistic Simulators for Training Humans and Artificial Intelligence (AI)

Supervisor: Dr Maria Chli (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr George Vogiatzis (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Luis J. Manso (School of Digital Engineering; Computer Science Department)

Area of Research: Multi-agent systems, Computer Vision, Machine Learning

Project Summary, Aim and Objectives: High-fidelity, photorealistic simulators are emerging as powerful training grounds both for human and autonomous operators. Current research strives to achieve realism in both the variety of scenarios and the behaviours of the actors these simulators encompass, to diminish the sim-to-real gap. In this suite of proposed topics, we will be expanding upon our work in urban modelling and traffic control to devise techniques for
(1) constructing simulation models directly from video footage that are faithful to real-life settings both in terms of the environment and the behaviours of the actors,
(2) generating new, realistic but previously unseen scenarios to widen the experience of the trainee, and
(3) use the simulator to produce individual and swarms of autonomous actors that may be deployed to effectively control features of the environment.

You will be working in a multi-disciplinary team of experts in Artificial Intelligence, multi-agent systems, robotics, simulation, machine learning and computer vision. his project is co-funded by Inzpire, an award-winning supplier of products, training and technical services in defence and other industrial sectors. The project will address one or more of the following topics:

- Synthetic environments to enhance Command and Control (C2) training
- Maximising the training value of synthetic environments
- Optimising sensor selection and coordination
- Simulation and coordination for global maritime operations
- Faithful depiction and development of urban scenes

Knowledge and skills required in applicant:
Familiarity with Python and ideally a Neural Network framework (pytorch/tensorflow). Good analytical/maths skills. Some experience with image/video processing would be advantageous.

2022-2023_057 - Optimizing the Electric Vehicle Charging Network

Supervisor: Dr Farzaneh Farhadi (School of Digital Engineering; Computer Science Department)
Assoc. Supervisor: Dr Maria Chli (School of Digital Engineering; Computer Science Department, Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Computer Science, Artificial Intelligence, Energy

Project Summary, Aim and Objectives: UK plans to ban sales of fossil fuel-powered vehicles from 2030, meaning electric vehicles (EVs) are going to be the future transport. However, the available charging infrastructure for EVs in the UK falls far below what is needed amid surging demand. In fact, while EV sales in the UK increased by over 400 percent over the past three years, the number of fast charging points grew by just 160 percent. This is potentially very dangerous, as we could soon reach a point where the growth of EVs uptake stalls if consumers conclude there are not enough charging points where they need to travel, or that they must queue too long for a fast charger.

In this project, you will be supervised by multi-disciplinary team of experts in Machine Learning, Multi-agent systems and Mechanism Design while collaborating with one of the UK's leading providers of rapid EV charging stations, to address this issue. The ultimate goal is to grow the public charge network to the correct scale and location to meet the growing demand. As the first step towards this goal, we utilize **machine learning**, **artificial neural networks**, and **statistics**, to model the emerging charging behaviour of the public. To develop a precise model, we also take advantage of **game theory** and **contract theory** to encourage customers to share more of their data. Based on this model, we then utilize **optimization** techniques to provide a cost-efficient network-expansion planning with optimal location and speed for EV charging stations.

The key objectives are to
1- Propose suitable mechanisms for eliciting customer behaviour
2- Construct consumer behaviour model
3- Develop methods to optimize the EV charging network for cost and reachability
4- Diversify and optimize customer contract offering to maximize market share

Knowledge and skills required in applicant:

The successful applicant will have a strong undergraduate and/or master's degree in computer science, engineering, mathematics or a related discipline as well as excellent programming and analytical/mathematical skills. A demonstrable interest in agent systems, machine learning and probabilistic modelling is essential.

2022-2023_058 - Integrating Infrastructure Compliance Checking with Building Information Modelling BIM

Supervisor: Dr Tala Kasim (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)
Assoc. Supervisor: Dr Algan Tezel (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)
Assoc. Supervisor: Professor Mujib Rahman (School of Infrastructure and Sustainable Engineering; Civil Engineering Department)

Area of Research: Building Information Modelling, Infrastructure, Digital Technologies, Civil infrastructure engineering, Information management system

Project Summary, Aim and Objectives: Regulatory compliance checking is used to assess roads performance against regulations, standards and requirements. Automated code compliance checking is the process of converting the traditional methods of manual checking into digital process using information management systems and Building information modelling.
Achieving automated compliance checking provides tangible advantages including enhanced project management, facilitate design compliance with regulations and provides accessibility to compliance information essential for operation and serviceability. This will result in economic benefit and improved efficiency.
Automated compliance checking has been implemented on buildings and the built environment world wide eg; Solibri, RegBIM, cornet Singapore. There has been some considerable achievements on the filed nevertheless, there has been a little attention on using BIM for infrastructure projects.
The overarching aim of this current project is to develop an automated code compliance checking on infrastructure projects (Roads). The possible research objectives are

1) Identify current workflow for regulatory compliance checking in infrastructure projects (Roads)
2) Identify the need and requirements across work flow (requirements, standards and regulations
3) Develop regulatory knowledge repository of the targeted regulation
4) export compliance requirements and map them to the developed knowledge repository
5) examine compliance results to validate the system on real scenario

Since Infrastructure design and construction is conditioned by numerous sustainability regulations and assessment measures, to promote sustainability, the research will possibly open a channel with major infrastructure project with national highways at a time when the sector has been facing immense challenges to move towards more- sustainable infrastructure with minimum harm to the environment.

Knowledge and skills required in applicant:
1. Knowledge of Civil, infrastructure, Construction, Building Information Modelling BIM
2. Knowledge of or willingness to learn digital technologies in construction applications

2022-2023_059 - The Design of Polymers for Oral Applications

Supervisor: Dr Brian Tighe (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute of Urban Technology and the Environment - ASTUTE)
Assoc. Supervisor: Professor Paul Topham (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute of Urban Technology and the Environment - ASTUTE)

Area of Research: Hydrogels**,** Biomimetic polymer design, Biomaterials, Polymers

Project Summary, Aim and Objectives: Most synthetic polymers are inherently hydrophobic, which was the initial intellectual stimulus to produce water-swollen (hydrogel) polymers. Although conventional hydrogels have proved to be very effective biomimetic soft tissue biomaterials for a range of applications, they fail to match the behaviour of natural tissue in several respects. This is exemplified by mucosal surfaces of the body, such as the ocular surface (the eye) and the oral cavity (the mouth).
To achieve optimal biocompatibility it is essential to look into the properties of the tissues in their native state – this will provide a platform to work towards in the challenge of designing synthetic analogues to mimic mucosal tissue sites. Cross-fertilisation of ideas from work in different body sites has aided the development of tissue analogues in the past and soft tissue work on oral and ocular tissue sites will arguably benefit from cross-fertilisation since material needs show similarities in (e.g.) contact lenses, artificial corneae, dental adhesives and drug delivery systems.
The chemical structure of mucins and proteoglycans gives some clues about their hydrophilicity. The molecules are made of sugar chains with specific hydrophilic groups positioned at the periphery. This shows clearly the significance of sulphate groups. Their brush-like structure enables the macromolecule to entrap and retain water more effectively than other hydrophilic molecules found in the body. Those characteristics are closely related to the presence of organic sulfate groups and it is the combined and controlled use of sulfate/sulfonate, amide and carboxyl pendant groups in purpose-designed polymers
The aim of this project will be to:

1. develop linear soluble, and formed film versions of biomimetic mucin/proteoglycan analogues
2. use the structures to develop dry-mouth therapies (of increasing importance for post-Covid patients)
3. use the structures to develop responsive coatings for fibre optic-based point-of-care sensors

Knowledge and skills required in applicant:
A strong degree in chemistry, materials science, biotechnology, chemical engineering or similar
An understanding of polymers and materials
A strong interest in experimental science

2022-2023_060 - Towards A Sustainable and Carbon-Neutral Future with Connected and Autonomous Electric Vehicles

Supervisor: Dr Muhammad Azmat (School of Infrastructure and Sustainable Engineering; Engineering Systems and Supply Chain Management Department)
Assoc. Supervisor: Dr Brian Price (School of Infrastructure and Sustainable Engineering; Engineering Systems and Supply Chain Management Department)

Area of Research: Smart & Sustainable Mobility, Logistics 4.0, Future of Transportation

Project Summary, Aim and Objectives
Electric Vehicles (EVs) offer the potential to reduce dependence on fossil fuel and greenhouse gas emissions. They could be used as a highly effective tool in the fight against Climate Change, yet their sales are lower than expected, mainly due to range anxiety and limited access to charging infrastructure. Therefore, to encourage potential buyers to buy and use EVs as their daily driver and to minimise the global carbon footprint significantly, we need to develop smarter, readily available and viable technical and business solutions. Which would not only encourage consumers to cope with disruptive technologies but also promote businesses to invest in them for better profits.
The outcome of the study would dictate:
• Changes in the current vehicle charging policies and regulations,
• A strategy for rolling out V2V/ V2G technology, as a national technology roadmap,
• Promote less reliance on building physical infrastructure and providing a more consumer and environment-friendly smart solutions for charging an EV.

In a 3 years PhD program, the candidate would examine the current state of technology readiness for V2V applications along with assessing the severity of existing challenges with vehicle charging infrastructure, the current state of V2V charging technology and propose its maturity timeline. Furthermore, highlight consumer perception about electric vehicles and their willingness to adapt to the smarter ways of charging their vehicles, and develop a policy guideline and the strategy for rolling out V2V technology as a national technology roadmap. Consequently, the candidate is expected to present V2V/V2G potential business applications; it's socio-economic benefits and trade-off analysis.

This consumer-centric project is in line with both The Global Sustainable Development Goals and UK's ambitious plans to end sales of combustion engines by 2030. The project would also address three of the top four priorities of the Department of Transport UK

Knowledge and skills required in applicant:

- Preferably a Bachelor's in Business Management, Engineering, or IT
- Master's in Business Management, Engineering, or IT (Specialization in Transport, logistics or SCM)
- Excellent knowledge of Modelling and Simulation software
- Excellent Quantitative and Qualitative methodology skills
- Comfortable with mathematical modelling like SEM, ASEM, ARIMA, Holt's Winter etc.
- Prior experience of publishing in internationally recognised peer-review journals is an advantage

Excellent (IELTS 7 or C1) English Language Skills

2022-2023_061 - Novel Compact Laser sources for Efficient Cancer Diagnostics and Therapy

Supervisor: Dr Sergei Sokolovski (Aston Institute of Photonic Technologies – AiPT)
Assoc. Supervisor: Professor Edik Rafailov (Aston Institute of Photonic Technologies – AiPT)

Area of Research: Biomedical Photonics. This project aims to advance the development of an integrated laser diagnostic and therapeutic technique based on utilising novel compact laser sources for the use in detecting, predicting prognosis and treating head and neck cancers.

Project Summary, Aim and Objectives: The main aim of this project is to generate validation data of a tissue absorption/fluorescence in response to healthy and cancer cell/tissue samples to develop a new diagnostic tool, which will be focussed on head and neck cancers and have potential widespread

application for early diagnosis of other types of solid cancer. In this part of the work, we will comprise experimental research in the optical analysis of cancer and non-cancer tissues. (Obj. 1) For this we will develop multifunctional diagnostic systems, which utilises a number of compact and efficient laser sources from 365nm to 1300nm. Optical analysis results will also be compared to head and neck cancer outcomes to assess its value as a prognostic tool. These data will be used in designing a 3D simulation model based on ex vivo normal and cancer tissue optic data using the Monte Carlo method and validate it in vivo (Obj.2). There also is strong interest in development of non-toxic cancer phototherapy. A promising approach is offered by generation of oxidative stress in cancer cells killing them with direct 1268nm laser-induced generation of singlet oxygen without administration of any toxic photosensitises. Since generated the single oxygen damages cell organelles to initiate selective cell apoptosis in cancer cells. It is thus particularly interesting to investigate the optical doses capable of destroying cancer cells by the LT without tissue overheating. Therefore, for further progress in this area, there is a clear need for advanced CW and pulsed laser sources around 1270 nm wavelength (Obj. 3).
Finally we propose a multi-disciplinary research programme to develop the new underlying laser technologies that form an advanced non-and/or minimally invasive photonic system for head and neck cancers diagnostics and phototherapy.

Knowledge and skills required in applicant: The knowledge of main principles of photonics, lasers, tissue light propagation and/or data analysis are desirable. The advantage will be practical skills in cell culturing and/or experience in bio-tissue handling in biolabs.

2022-2023_062 Developing An Implantable Infection Biosensor for Long Term Implant Monitoring

Supervisor: Sarah Junaid (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE / Aston Institute of Materials Research
Assoc. Supervisor: Anisa Mahomed (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department / Aston Institute for Urban Technologies and the Environment - ASTUTE / Aston Institute for Materials Research)
Assoc. Supervisor: Laura Leslie (School of Engineering and Technology; Mechanical, Biomedical and Design Engineering Department / Aston Institute of Urban Technology and the Environment - ASTUTE / Aston Institute of Materials Research)

Area of Research: Healthcare and Biomedical engineering

Project Summary, Aim and Objectives: Infection is a serious challenge in the field of orthopaedic surgery. The number of hip and knee replacements in the UK alone was almost **165,000 in 2013** (NJR Reports). In the USA the figure was **860,000 in 2016** (AJRR Annual Report 2017). Implant infections not only increase the risk of revision surgery but also lead to an economic burden on patients and risk of antimicrobial resistance (AMR). The rate of infection after primary joint replacement can be up to 9 % and is significantly higher after revision surgery to up to 40 %. Currently, the diagnostic techniques that are applied to detect and study implant-associated infection (septic loosening) involve radiographic analysis, pathological assessment, and various blood culture tests. However, the results from these techniques are often inaccurate, not timely and are unable to detect the infection at an early stage.

Therefore, in this doctoral study, our aim is to develop an implantable sensor, which can detect early signs of infection around the implant. In a preliminary seedcorn-funded study, a biocompatible material

was synthesised that can respond to change in its surrounding and a standard operating procedure (SOP) has been established.

This doctoral study will build on this work by refining the biomaterial formulation and embed a sensor that has been previously developed to detect motion without the need for radiographic imaging. The aim is to develop a system that can remotely detect infection development in real time, allowing for immediate and timely intervention without the need for X ray exposure.

Knowledge and skills required in applicant:

Materials science
Mechanical engineering