Call for Engineering and Physical Sciences DTP PhD Applicants – Academic Year 2022 - 23 - List of 2023-24 Projects

Deadline for applications: 31st January 2023

Areas Of Research

Aston Institute of Photonic Technologies - AiPT

Photonics, Optical Communications, Integrated Photonics, Digital Communications, Digital Image Processing, Optics, Photonic Sensors, Civil Engineering, Lasers, Polymer Science, Renewable Energy, Nanotechnology, microelectrode arrays, ink-jet printing, electrophysiology, ultrafast laser microfabrication, fibre optical device, gas sensing , mid infrared , laser spectroscopy, Photonic Devices, Digital Signal Processing, , Modelling, Sensors, Spectroscopy Devices, Materials, Sensors, Machine Learning

See list of Aston Institute of Photonic Technologies – AiPT, projects HERE

Energy and Bioproducts Research Institute - EBRI

Plastic Waste, Chemical Recycling, Circular Economy, Catalytic Pyrolysis, Sustainability, Biomass, Artificial Intelligence, Hydrogen, Membrane, Fuel Cell, Biofuels, Heterogeneous Catalysis, Membrane, Water Treatment, Wastewater, Chemical Engineering, CO_2 Conversion, Clean Energy, Green Catalysis, Sustainable Plastics, Bioprocessing, Waste Valorisation, Microbiology, Bioenergy, Gasification, biochar, Sequestration, Heat storage; Heat Upgrading; Bioheat; Renewable Heat, Mechanical Engineering, Thermal Energy, Heating and Cooling, Air Conditioning, Heat Pump, Platform Chemical, Aqueous-phase, Catalysis, Catalyst development (synthesis, characterisation and testing), Nanomaterials, Low Carbon Fuels, Advanced Combustion, Emissions, Engine Performance

See list of Energy and Bioproducts Research Institute – EBRI, projects HERE

Engineering and Technology - Mechanical, Biomedical and Design Engineering Department

Autonomous Systems, Control Engineering, Automotive, Smart and Sustainable Manufacturing, Energy Management, Cyber-Physical Production System, Digital Twin, Sensors, Reinforcement Learning, Biodegradable Surgical Implants, Neuroscience, Bioengineering, Functional Connectivity, Brain And Muscle Dynamics, Assistive Living, Real-Time Monitoring, Internet of Things (IoT), Internet of Medical Things (IoMT), Remote Monitoring, Sustainable Energy And Transport, Low Carbon Fuels, Advanced Combustion, Emissions, Engine Performance, Photonics Technologies, Ophthalmology, Optometry, Vision Science

See list of Mechanical, Biomedical and Design Engineering Department projects HERE

Informatics and Digital Engineering - Computer Sciences Department

Machine Learning, Computational Intelligence, Bioinformatics, Multi-agent systems, Computer Vision, GIS, Air Quality, Risk Assessment, Model-based Cybersecurity, AI, NLP, HCI, Cognitive Functioning, Knowledge Graph, Software engineering, Networked Unmanned Aerial Vehicles, Cooperative Navigation, Hybrid Wireless Networks, Explainable AI, Ethics of AI, Data Bias Artificial Intelligence – AI, Natural Language Processing, Optimisation, Cybersecurity, Internet of Things, Middleware, Artificial Life, Neuroevolution, Multi-Agent Systems, Vision, , Computer Science, Energy, Medical Imaging, Deep Learning, Eye tracking, Innovative labelling, Robotics, Ethics, Roboethics, Autonomous Systems, Long-term Autonomy, Quantum Physics.

See list of Computer Sciences Department projects HERE

Informatics and Digital Engineering – Electronical and Electrical Engineering Department;

Cancer, Biomaterials, Bone, Bioactive Glass, Mobile Networks Computing, Intelligent Transport, Smart Cities, Internet of Things

See list of Electronical and Electrical Engineering Department projects HERE

Informatics and Digital Engineering – Maths Department

Statistical Physics, Complex Systems, Mathematics, Signal Processing, Artificial Intelligence, Fluid Dynamics, Mathematics, Computer Science, Multiscale Molecular Dynamics, Hydrodynamics, Probabilistic inference, Cortical Activity, Visual Informatics, Entropy

See list of Mathematics Department projects HERE

Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department

Energy, Sustainability, Electrochemistry, Polymers, Materials, 2d Nanomaterials, Pollution Treatment, Chemical Vapour Deposition, Metal Compounds, Polymerisation, Polymer Chemistry, Chemical Engineering, Catalysis, Biomaterials, Stem Cells, Cultivated Meat, Tissue Engineering, Electrospinning, Water Purification, Protein, Polymer, Membranes, Computational Fluid Dynamics (Cfd), Fluid Mechanics, Fluid Dynamics, Fluid Flow Simulation, Bioenergy, NMR, Spectroscopy, Hydrogels; Antimicrobials; Drug Delivery

See list of Chemical Engineering and Applied Chemistry projects HERE

Infrastructure and Sustainability Engineering – Civil Engineering Department

Construction/Manufacturing Informatics, Construction Management and Engineering, Construction/Manufacturing Ergonomics, Health And Safety, Wearable Sensors And Robotics, Bio-Inspired, Ground Improvement, Sustainable Infrastructure, Finite Element Analysis, Experimental Modelling, Green Infrastructure, Reducing Carbon Emission, Civil Engineering, Infrastructure Monitoring, Structural Health Monitoring, Sensing, Building Information Modelling, Digital Construction

See list of Chemical Engineering and Applied Chemistry projects HERE

Infrastructure and Sustainability Engineering – Engineering Systems and Supply Chain Management

Traffic Congestion, Transport, Emissions, Charges, Cities, Supply Chains, Control Theory, Metasystem, Optimisation, Upscaling, Renewable Energy Supply Chains, System Dynamics, Supply Chain Disruptions, Digitalisation, Resilience, Digital-Twin Capability, Digital Transformation, Sustainable, Big Data, Block Chain, Supply Chain 4.0,

See list of Chemical Engineering and Applied Chemistry projects HERE

Individual Research Projects

Aston Institute of Photonic Technologies - AiPT

Photonics, Optical Communications, Integrated Photonics, Digital communications, Digital Image Processing, Optics, Photonic Sensors, Civil Engineering, Lasers, Polymer Science, Renewable Energy, Nanotechnology, microelectrode arrays, ink-jet printing, electrophysiology, ultrafast laser microfabrication, fibre optical device, gas sensing , mid infrared , laser spectroscopy, Photonic Devices, Digital Signal Processing, , Modelling, Sensors, Spectroscopy Devices, Materials, Sensors, Machine Learning

Optically Enhanced Transponders for Digital Futures

Prof Andrew Ellis (Aston Institute of Photonic Technologies - AiPT)
Dr Ian Phillips (Aston Institute of Photonic Technologies - AiPT; School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Project Summary Aim and Objectives

Communication networks are now deeply into the predicted capacity crunch, with research attention focussed on achieving massive parallelism (wavelength and spatial multiplexing) and systems operating close to the signal to noise ratio of analogue to digital converters. To fully exploit the characteristics of such systems, using multiple-input multiple-output technology, and maintain cost per bit reductions will require advanced media converters to access bandwidths and digital resolutions (effective number of bits) beyond the scope of conventional electronics. Using optical frequency combs and optical interferometers, implemented integrated photonics, this project will develop advanced media converters for wide range of conventional optical communication applications, including long haul and access networks, data centres and free space communications, in addition to novel spatially multiplexed networks where enhanced super-linear performance will be demonstrated. On completion of their PhD the successful applicant will be an expert in outsourced opto-electronic component manufacture and optical communication systems.

Knowledge and skills required in applicant:

Applicants should have been awarded, or expect to achieve, a First Class Honours degree (or equivalent from an overseas institution), in Physics or Electronic Engineering, or a Masters degree with Distinction in a subject related to optical communication. Preferred skill requirements include practical experience of optical communications or integrated photonics.

Novel photonics based techniques for biomedical applications

Prof Edik Rafailov (Aston Institute of Photonic Technologies - AiPT)
Prof James Wolffsohn (College of Health and Life Sciences, School of Optometry)

Project Summary Aim and Objectives Microvascular blood flow is a key indicator of tissue health and disease progression. Current measurement techniques typically choose between quantification (e.g. laser Doppler flowmetry, OCT-angiography), or wide-field measurements (e.g. laser speckle imaging), limiting clinical utility. Multiple exposure speckle imaging in principle offers both, but requires much more complex data processing, both in terms of hardware and data analysis.

The PhD candidate will develop advanced models based on analytical and Monte Carlo methods to convert multiple exposure speckle imaging data into quantitative blood flow information, and develop signal and data processing methods to advance multiple exposure speckle imaging systems as a clinical tool. This work will build on the laser Doppler flowmetry work developed by Professor Rafailov and speckle imaging work at industry partner Occuity, a leading medical engineering company based in Reading, and will be split between Aston and Reading. .

Knowledge and skills required in applicant:

Applicants should have: An honours degree (1st Class or 2:1 minimum) in physics or closely related subject. Experience working in a laboratory environment. An interest in sensors and devices. A willingness to learn new experimental and analytical techniques.

Smart photonic sensing for resilient civil engineering infrastructures

Dr Auro M. Perego (Aston Institute of Photonic Technologies - AiPT)
Dr Hani Kbashi (Aston Institute of Photonic Technologies - AiPT)
Dr Haris Alexakis (School of Infrastructure and Sustainable Engineering - Civil Engineering Department)

Project Summary, Aim and Objectives:

Real time and reliable monitoring of building and transport infrastructure is crucial to predict failures and damages that could endanger people lives, have serious societal impact, and affect the economy. Photonic sensors are a

promising solution for accurately monitoring civil engineering infrastructures in harsh environments. In this project, the PhD candidate, working in a novel research line, will develop a fibre laser sensor to detect strain, pressure, and acoustic emission waves in civil engineering infrastructures. The research, covering experimental work, numerical modelling and field testing, will be conducted in the highly stimulating and multidisciplinary environment offered by AIPT, in collaboration with Aston Civil Engineering department. The candidate will furthermore enjoy the opportunity of a secondment at the University of Cambridge, where, together with our partners (Prof. Sheil's group), they will perform tests at the state-of-the-art National Research Facility for Infrastructure Sensing, and will develop Machine-Learning algorithms for smart data processing.

Knowledge and skills required in applicant:

The candidate will have a background in engineering or physics (BSc/MSc level). Knowledge about experimental techniques, either in photonic devices (lasers, fibre optics) or in sensing, especially for civil engineering, is essential. Knowledge of numerical methods for photonics or civil engineering, signal processing and machine learning techniques, is desirable.

Innovative polymer coatings for use in real-time fibre-optic sensing of wind turbine blades

Prof David Webb (Aston Institute of Photonic Technologies - AiPT)

Professor Paul Topham (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department

Dr Matthew Derry (School of Infrastructure and Sustainable Engineering; Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives

Large wind turbines can change the blade pitch to optimise the load, reducing imbalance and wear on key structural components. These smart structures are enabled by real time data collected by optical fibre strain sensors. In partnership with a world-leading optical fibre strain sensing company, this project seeks to address challenges relating to embedding fibres into polymer composites such as fibreglass and carbon fibre for high value markets such as renewable energy, automobile and aerospace. Technical challenges remain a barrier to widespread commercial adoption due to reliability of the embedding process. This project will focus on the design and creation of an innovative polymer coating to address three key challenges that hinder the current state-of-the-art: (1) minimise the composite shrinkage-induced micro-bending of the fibre; (2) minimise the fibre Bragg grating distortion during composite curing; (3) investigate means to ruggedise the fragile optical fibre exit point from the composite structure.

Knowledge and skills required in applicant:

Applicants should have: An honours degree (1st Class or 2:1 minimum) in chemistry or closely related subject. Demonstrable experience working in a laboratory environment. A strong interest in polymer science. A willingness to learn new experimental and analytical techniques.

Ultra-Fast Data Transmission in Free-Space Optical Communications

Dr Yiming Li (Aston Institute of Photonic Technologies - AiPT)

Prof Andrew Ellis (Aston Institute of Photonic Technologies - AiPT)

Project Summary, Aim and Objectives:

In this project, we will employ mode-division multiplexing (MDM) multiple-input multiple-output (MIMO) technologies to enable record-high multiple Terabit transmission in the communication systems, allowing ultra-fast satellite communications and Ground-to-Ground wireless communications. This project will be supported by the Aston Institute of Photonic Technologies, a world-leading optical communication laboratory, which provides cutting-edge experimental instruments, computation resources, and office resources. The successful applicant will also have a good chance of secondment to world-leading research institutes such as Nokia Bell Labs. After the PhD research, we anticipate the student to have a strong and comprehensive knowledge of cutting-edge experimental communication systems, including digital signal processing, channel modelling, digital image processing, and even physical optics, allowing him/her to be a strong candidate in both academia and industry in his/her future careers.

Knowledge and skills required in applicant:

We anticipate the candidate to have a strong knowledge of electrical engineering, especially in digital communications and digital signal processing. It is also preferable that the students have a good knowledge of digital signal processing and optics. The experience of writing journal papers will be also preferred.

.

Nanotechnology, microelectrode arrays, ink-jet printing, electrophysiology

Dr Petro Lutsyk (Aston Institute of Photonic Technologies – AiPT; School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Dr Stuart Greenhill (College of Health and Life Sciences ; Aston Institute of Health and Neurodevelopment)

Dr Alex Rozhin (Aston Institute of Photonic Technologies – AiPT; School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Project Summary, Aim and Objectives:

The motivation for the proposed research stemmed from the fact that there is currently a gap and developmental opportunities in the technology of biocompatible microelectrode arrays (MEAs) for the electrophysiological study of brain pathologies, in particular epilepsy. The project goal is to overcome the limitations of current MEAs restricting the supply of O2/CO2 to the interface of studied tissue and the arrays and to open novel avenues for a dramatic change in brain signal recording. A new design using nanotechnology can ensure the brain tissue does not become anoxic in a couple of hours and can be studied for a long time providing ground-breaking opportunities for brain electrophysiology. To this end, the following Research Objectives (ROs) will be pursued:

• RO1: To develop & optimise nanofabrication protocol for biocompatible MEA using inkjet printing technology & deploying MEAs to investigate its biocompatibility.

• RO2: To validate innovative MEA in electrophysiological studies of brain tissues."

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.

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

Dr Kaiming Zhou – (Aston Institute of Photonic Technologies – AiPT)

Prof Sergey Sergeyev (Aston Institute of Photonic Technologies - AiPT)

Prof Sergei Turitsyn (Aston Institute of Photonic Technologies - AiPT)

Project Summary, Aim and Objectives:

Many applications require to find spatial distribution of targeted substances precisely and fast. To this end, this project combines three advanced technologies: the distributed/discrete fibre optical sensing, mid infrared fibre laser spectroscopy and machine learning for highly sensitive 3D mapping of chemicals in real time. These three fields have seen remarkable advances in recent years. The distributed/discrete fibre optical sensing have been used for structure health monitoring in aerospace, civil engineering and geographic monitoring. Mid infrared is the spectral fingerprint region of many organic substances interested to life sciences, and industries including food and agriculture, pharmaceuticals and chemistry processing. Machine learning represented by deep learning have revolutionised the artificial intelligence and provided the unprecedented possibilities for tasks which used to be impossible. With the novel combination of three technologies, this project will advance research covering laser microfabrication of devices, mid infrared fibre laser, signal processing and data interpretation in time domain and spectral domain for 3D sensing.

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, sensor and sensing, metrology or other relevant subjects. Preferred skill requirements include knowledge/experience of fibre optics and lasers.

High capacity optical transponders for next generation communication systems

Dr Stylianos Sygletos (Aston Institute of Photonic Technologies - AiPT)

Prof Andrew Ellis (Aston Institute of Photonic Technologies - AiPT)

Prof Sergei Turitsyn (Aston Institute of Photonic Technologies - AiPT)

Project Summary, Aim and Objectives:

Optical communications have been a cornerstone of our information-based society. However, to keep up with their role, they must continue serving an exponentially increasing traffic demand while preventing a comparable growth in energy consumption. This requires new transceiver technologies characterized by an enhanced operational bandwidth, low power consumption and the ability to deal with signals of high spectral efficiency. The proposed PhD project aims to redesign the architecture of future optical transponders by exploiting the photonics to:

a) Develop power-efficient all-optical schemes for analogue-to-digital (ADC) and digital-to-analogue (DAC) conversion in the transceiver hardware to enable high-capacity transmission/detection of telecommunication signals

b) Enhance the performance of the existing electronic DAC/ADC circuits through pioneering analogue signal processing and time bandwidth engineering in the optical domain

c) Evaluate the performance of the developed schemes in various transmission scenarios, targeting world-record results in terms of transmitted spectral efficiency and data rate.

Knowledge and skills required in applicant:
The applicant needs to have a strong background on optical communications and waveguide theory of photonic devices. Strong mathematical modelling skills of photonic components and telecommunication systems, e.g. using Matlab/Python will be needed. Prior experience in the design of photonic components using the Lumerical Suite will be also appreciated.

Real-Time Digital Backpropagation for Fibre-Optic Communication Systems

Dr Morteza Kamalian-Kopae (Aston Institute of Photonic Technologies - AiPT)
Dr Stylianos Sygletos (Aston Institute of Photonic Technologies - AiPT)
Prof Sergei Turitsyn (Aston Institute of Photonic Technologies - AiPT)

Project Summary, Aim and Objectives:
Growing demand for data pushes the global optical network to its limits where our conventional techniques borrowed from linear communication systems are ineffective. One of these limits comes from the intrinsic nonlinearity of the fibre channel which makes it fundamentally different from common communication channels. The nonlinearity of the fibre greatly limits what can be achieved through optical communication. Although this problem has been studied and investigated by researchers for several years, there is still a lack of a commercially viable technique to mitigate nonlinearity in modern optical systems. The current state-of-the-art is either limited to offline signal processing or real-time processing of the signal with small nonlinear distortion with limited applications. This project aims at implementing a real-time nonlinearity mitigating DSP for single-channel coherent optical communication systems.

Knowledge and skills required in applicant:
Essential: knowledge of Digital Signal Processing and familiar with Optical Communication concept, knowledge of machine learning and fluent in programming languages including C++ and Python; Desirable: Experience in designing ASIC, FPGA and work with hardware

Development of sapphire based optical fibre sensors for extreme condition monitoring

Prof Kate Sugden (Aston Institute of Photonic Technologies – AiPT; School of Informatics and Digital Engineering; and Electrical and Electronic Engineering Department)
Dr Kaiming Zhou – (Aston Institute of Photonic Technologies – AiPT; School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Project Summary, Aim and Objectives:
Condition monitoring in harsh environments such as at high temperatures, pressures or corrosive liquids is critically important for improving efficiency and prolong machinery lifetime. These environments can easily damage electronic based sensor circuitry. Aston University has an established track record on fibre optical sensor and sensing technologies which have been used in civil engineering , aerospace, oil, biochemistry etc. In partnership with a leading optical fibre company, this project seeks to overcome limitations of common glass optical fibre including low resistance to corrosive liquids such as hydrofluoric acid and relatively low melting point by exploring the development of a new class of fibre optical sensors made from sapphire. The properties of sapphire make it attractive for harsh environments monitoring but these properties present challenges related to processing and sensor fabrication. This project will develop the fabrication of sensors composed from this material and its practical use in harsh environments.

Knowledge and skills required in applicant:
Applicants should have: An honours degree (1st Class or 2:1 minimum) in physics or closely related subject. Experience working in a laboratory environment. They must have an interest in sensors and ultrafast laser processing and a willingness to learn new experimental and analytical techniques.

A state of art BIOsensor from a novel photonic polymer transducer for a low cost rapid field deployable diagnostic instrument capable of Avian Influenza detection.

Dr Daniel Hill (Aston Institute of Photonic Technologies - AiPT)
Dr Kaiming Zhou – (Aston Institute of Photonic Technologies – AiPT)
Prof David Webb (Aston Institute of Photonic Technologies - AiPT)

Project Summary, Aim and Objectives:
In collaboration with colleagues in EBRI (Dr Alfred Fernández-Castané), LHS (Prof. Anna Hine), EPS (Dr Thomas Thatapudi) and leading academic and industrial collaborators outside of Aston it is proposed to use a novel detection scheme that through exploiting a weakness of polymer photonics will not only lead to the first ever optical biosensor in such a material but also three beyond state of the art achievements:
(1) Polymer photonic biosensing - in limit of detection 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).

Knowledge and skills required in applicant:
Essential: Practical experience in developing and utilising optical setups. General laboratory skills, data taking and analysis. 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: Experience in COMSOL/RSoft/Lumerical, LabView, photonics, microfabrication.

Energy and Bioproducts Research Institute - EBRI

Plastic Waste, Chemical Recycling, Circular Economy, Catalytic Pyrolysis, Sustainability, Biomass, Artificial Intelligence, Hydrogen, Membrane, Fuel Cell, Biofuels, Heterogeneous Catalysis, Membrane, Water Treatment, Wastewater, Chemical Engineering, CO_2 Conversion, Clean Energy, Green Catalysis, Sustainable Plastics, Bioprocessing, Waste Valorisation, Microbiology, Bioenergy, Gasification, biochar, Sequestration, Heat storage; Heat Upgrading; Bioheat; Renewable Heat, Mechanical Engineering, Thermal Energy, Heating and Cooling, Air Conditioning, Heat Pump, Platform Chemical, Aqueous-phase, Catalysis, Catalyst development (synthesis, characterisation and testing), Nanomaterials, Low Carbon Fuels, Advanced Combustion, Emissions, Engine Performance

Chemical recycling of plastic waste for circular economy

Dr Jiawei Wang (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Dr Marta Granollers-Mesa (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:
The threats that plastic pollution poses to the environment and public health have raised global awareness among the general public, businesses, and governments. To solve the problem of waste plastic in a sustainable and Net-Zero manner, it is important to develop feasible methods to convert plastic waste into usable chemicals and close the loop of the circular economy. Propylene (C3) and butenes (C4), potential products from plastic waste, are common platform chemicals for the material and pharmaceutical industries. In this project, the candidate will design a chemical recycling method utilising innovative catalysts to transform non-recyclable plastic waste into high-yielding C3 and C4 products. The objectives of the project are: 1. Development of a multi-stage pyrolysis-upgrading process to convert plastic to C3/C4 products, 2. Development of novel catalysts for the chemical recycling process, 3. Understanding of the environmental impact of the process.

Knowledge and skills required in applicant:
Essential: A first-class or upper second-class honours degree in chemical engineering or chemistry. Basic chemistry laboratory skills. Desired: Knowledge on pyrolysis and catalysis. Lab experience on catalyst characterisation and catalystic pyrolysis.

Advanced sustainable bioplastics from renewable resources

Dr Paula Blanco-Sanchez (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Professor Paul Topham (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department
Dr Harry Goldingay (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:
99% of current plastics are made from fossil fuels and 91% of all plastics made to date have ended up in landfill, our environment or incineration plants. It's not all bad news however, as plastics save us over 580 million GJ (gigajoules) of energy per year (compared to using non-plastic alternatives) and will therefore play a pivotal role in our quest to net zero. Our research question is: Can we use Artificial Intelligence to identify viable, efficient and sustainable routes from biomass waste to high value chemicals for bioplastic production?
Current methods of producing biofriendly plastics are limited to known, relatively expensive pathways. The use of machine learning will allow screening of potential biomass-to-plastic routes to enable this highly ambitious project

to succeed. Ultimately, this project will address the huge issue with waste plastics by generating a new family of degradable plastics using renewable feedstocks via the most carbon-neutral pathways.

Knowledge and skills required in applicant:
Applicants should have: An honours degree (1st Class or 2:1) 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; A willingness to learn new experimental/analytical techniques and digital technologies, including Python programming language.

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

Dr Amirpiran Amiri (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Dr J. Ricardo Sodré (School of Engineering and Technology – Mechanical, Biomedical and Design Engineering Department)
Professor Robert Steinberger-Wilckens (University of Birmingham - School of Chemical Engineering

Project Summary, Aim and Objectives:
If you are interested in 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.

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

Membrane-based nanoconfined heterogeneous catalysis for abating organic micropollutants in water

Dr Zhentao Wu (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Prof Patricia Thornley (Energy and Bioproducts Research Institute - EBRI)

Project Summary, Aim and Objectives:
Recalcitrant micropollutants (pharmaceuticals, pesticides etc.) widely existing in water threatens global water safety, human health and wellbeing. Advanced Oxidation Processes outweigh conventional water-treatment technologies by generating in-situ reactive oxidation species (hydroxyl and/or sulfate radicals) unselectively decomposing the contaminants. However, the solid-phase catalytic materials in AOPs cause nano-hazards in water and require extra separations. The short lifetime of oxidation species (1-40 microsecond) also demands advanced material/system designs for efficiently removing the micropollutants. To address these issues, AOPs catalysts will be integrated with micro-tubular ceramic membranes to form an advanced catalytic membrane for (1) immobilizing nano-structured catalyst, (2) intensifying interactions between catalyst and micropollutants, (3) separating particulates (0.01-10 micrometre) in water, (4) reducing membrane biofouling and (5) developing compact and high-throughput unit/system toward engineering applications. This project aligns directly with the water in Goal-6 of Sustainable Development Goals, and links to poverty reduction, food security, peace and ecosystems in other Goals.

Knowledge and skills required in applicant:
Applicants would expect to show relevance in the criteria scope below: Education and qualification: BEng (BSc), MEng (MSc) in chemical, material, environmental or mechanical engineering, or general engineering background Research experience: material design, preparation, processing, characterization and performance evaluation; membrane science and technology; water and wastewater treatment; heterogenous catalysis.

Removal of hazardous metals from water

Dr Vesna Najdanovic (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)
Dr Alfred Fernandez-Castane (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:
Due to their widespread utilization, heavy and transitional metals is an emerging group of xenobiotics detected in various surface waters, causing serious public health and environmental problems. Currently, conventional wastewater treatment plants are not fully adapted to remove these micropollutants. Therefore, developing sustainable and cost-effective alternative technologies for wastewater treatment is of utmost importance to ensure water availability and sustainable management, addressing one of the major concerns of the 21st century as adopted by the UN 2030 Agenda for Sustainable Development.
This project aims to improve the removal of metal residues from aqueous solutions using novel systems based on biorenewable and environmentally friendly solvents. The student will receive high-quality training in sustainable technology and environmentally friendly new processes, enhancing career prospects in both national and international settings in private and public sectors.

Knowledge and skills required in applicant:
Applicant should have a degree in Engineering, Chemistry, Materials Science, Physics or a related discipline. The applicant should demonstrate excellent oral and written communication skills with the ability to prepare presentations, reports and journal papers as well as excellent interpersonal skills to work effectively in a multi-disciplinary environment.

Catalytic conversion of CO2 and industrial waste streams to hydrogen

Dr Marta Granollers-Mesa (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Dr Amin Osatiashtiani (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:
Climate change has driven the need to address three challenges related to global sustainable development: the push for energy sources that minimise climate change, such as hydrogen (challenge 1); the efficient use of natural resources (challenge 2); and the development of large-scale negative greenhouse gas emission technologies based on carbon capture, storage and/or conversion to counteract the effects caused by greenhouse gas emissions (challenge 3). This project addresses these three challenges simultaneously as it proposes the application of inexpensive catalysts to transform industrial waste streams and carbon dioxide captured from air to produce hydrogen. The project objectives are: 1. Synthesis and characterisation of novel, affordable and robust catalysts for hydrogen production. 2. Correlation of the catalyst properties to hydrogen production and catalyst lifetime. 3. Evaluation of the reaction mechanism, and optimisation of the catalyst properties and operating conditions to maximise hydrogen yield and process sustainability.

Knowledge and skills required in applicant:
Essential: 1) A first-class or upper second-class honours degree in chemistry or chemical engineering. 2) Basic chemistry laboratory skills. 3) Computer literacy (e.g., Microsoft Office). Desired: 1) Knowledge on catalysis. 2) Lab experience in catalyst characterisation.

Bioprocess intensification to accelerate sustainable bioplastics biomanufacturingn

Dr Alfred Fernandez-Castane (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)
Dr Vesna Najdanovic (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department))

Project Summary, Aim and Objectives:
Developing sustainable biomanufacturing routes for the industrial production of renewable biofuels and high-value chemicals is a high priority in establishing a low-carbon economy. Biobased polymers such as polyhydroxyalkanoates (PHA) can be used as a sustainable feedstock to produce a range of valuable compounds used in the packaging and biomedical industries. An integrated process for converting agricultural waste into biopolymers has been recently developed in our research group. To improve the technology, it is of critical importance to investigate the biological mechanisms and engineering challenges of the underlying bioprocess at each step through a whole-systems approach.
This PhD project aims to improve the performance of key steps including feedstock pre-treatment, microbial cultivation, biopolymer accumulation, and products separation using advanced data analytics techniques and bioprocess intensification to develop a controllable and scalable process.

Knowledge and skills required in applicant:
Applicants should have a degree in Biochemical Engineering, Biochemistry, Biotechnology or a related discipline. The applicant should demonstrate excellent oral and written communication skills with the ability to prepare

presentations, reports and journal papers, as well as excellent interpersonal skills to work effectively in a multi-disciplinary environment. .

The utilisation of char from biomass advanced thermal conversion to contribute to greenhouse gas reduction

Dr Scott Banks (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Dr Paula Blanco-Sanchez (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)
Dr Amin Osatiashtiani (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:

Advanced thermal conversion (ATC), such as gasification and pyrolysis, of biomass and waste is one of many possible solutions for developing sustainable energy vectors. Gasification can produce sustainable hydrogen and has Carbon Capture and Storage capability. Pyrolysis produces a liquid product that can be upgraded to high-value products. However, both processes create a solid carbon-rich product known as char. Char can be combusted in combined heat and power to provide process heat for pyrolysis, but to date, there are no commercial utilisation options for the char from gasification.

This project aims to identify possible utilisation options for char from ATC to enhance the greenhouse gas reduction capability of the overall ATC systems. These applications range from soil amendment, activated carbon, building material etc. The complete characterisation of char from different feedstocks and ATC will be required as this is a key differentiator that will define the end-of-use application.

Knowledge and skills required in applicant:

Applicants should have, or be about to obtain, a good First or Upper Second class honours degree in Chemistry / Chemical Engineering or a closely related subject. Prior experience in analytical characterisation equipment and good practical skills with a willingness to learn new experimental/analytical techniques would be desirable.

Compact and responsive sorption thermal energy storages: material-to-system level development

Dr Ahmed Rezk (Energy and Bioproducts Research Institute - EBRI; School of Engineering and Technology – Mechanical, Biomedical and Design Engineering Department)
Prof Richard Martin (School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)
Prof Patricia Thornley (Energy and Bioproducts Research Institute - EBRI)

Project Summary, Aim and Objectives:

The annual demand for heating is 4.9 Billion tonnes of oil equivalent worldwide. The heating demand in the UK alone accounts for 38% of the nationwide energy demand. Therefore, there has been an increasing need to meet this demand by utilising renewable resources, such as bioheat, solar and underground heat. Still, they are intermittent and require advanced heat storage.

Sorption heat storage is the next-generation technology that provides the highest possible storage density compared to the other alternatives. However, the poor thermal performance of the existing materials bottlenecks the development of effective systems. The project, therefore, aims to develop new materials, components and system designs to overcome the heat and mass transfer limitations and accelerate the heat charging/discharging rate in sorption heat storage.

The research will require material formulation, component and system modelling using real-life data, utilising state-of-the-art laboratories at Aston University and engaging with industry.

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 be willing to learn material formulation and characterisation skills. In addition, the applicants will submit a research proposal to demonstrate their ability to undertake outstanding research and plan efficiently.

Ground source solid-state compression heat pump for residential building

Dr Muhammad Imran (Energy and Bioproducts Research Institute - EBRI; School of Engineering and Technology – Mechanical, Biomedical and Design Engineering Department)
Dr Ahmed Rezk (Energy and Bioproducts Research Institute - EBRI; School of Engineering and Technology – Mechanical, Biomedical and Design Engineering Department)

Dr Abul Kalam Hossain (School of Engineering and Technology - Mechanical and Biomedical and Design Engineering Department)

Project Summary, Aim and Objectives:

Due to the increasing concerns about the global warming effect of refrigerants, natural refrigerants (water, CO2) heat pumps are gaining attention as replacements for current vapor compression heat pumps. This project aims to design and analyze the performance of a solid-state compression heat pump based on the shape memory alloy (compound of nickel and titanium), which employs water as a refrigerant. In solid-state compression, the shape memory alloy is compressed to release heat, and then the cycle is reversed for cooling. The key objectives of the Ph.D. project are 1) Development of the system and component-level numerical model of the solid-state compression heat pump; 2) Experimentation and numerical modelling of the compression/bending and uniaxial tension of the shape memory alloy (compound of nickel and titanium); 3) Development of the physics-based performance assessment models and maps of the solid-state compression heat pump. This exciting Ph.D. project will involve experimental works, numerical modelling, and an opportunity to work closely with relevant industrial partners.

Knowledge and skills required in applicant:

This project requires fundamental understanding of the heat pump, heat transfer, thermodynamics, and expertise and experience in numerical modelling of thermal energy systems.

Thermocatalytic processing of biomass pyrolysate for production of platform chemicals and alternative biofuels

Dr Jude Onwudili (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Dr Paula Blanco-Sanchez (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:

Novel biorefinery concepts based on integrated technologies have the potential to achieve Net Zero and combat climate change. For example, steam-assisted pyrolysis process uses woody biomass to produce a sugar-rich liquid (pyrolysate), which is currently mostly used for bioethanol production via fermentation. While bioethanol-based biorefinery appears currently viable, such single-product concepts can fail in the face of unfavourable policies and economic fluctuations. Therefore, there is need to diversify biorefinery product streams to ensure financial stability and sustainability via various income streams. The proposed PhD research will investigate novel aqueous-phase thermocatalytic routes for converting pyrolysate into platform chemicals such as levulinic acid, succinic acid, 2,5-furandicarboxylic acid, lactic acid and oxygenated aromatics. These chemicals can be applied to produce pharmaceuticals, bioplastics, flavourings, cosmetics and other household items. The proposed research will be in partnership with a leading company in the sector, thereby providing a route for commercial exploitation of the research outcome.

Knowledge and skills required in applicant:

Catalysis, thermochemical process, chemical analysis, organic chemical reactions, reaction engineering, time management, technical research skills, writing skills, analysis and interpretation of results

Catalyst development for the conversion of bio-ethanol to aviation fuels

Dr Qingchun Yuan (Energy and Bioproducts Research Institute - EBRI)

Dr Daniel Jozef Nowakowski (Energy and Bioproducts Research Institute – EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:

This project aims to develop new catalysts that convert bio-ethanol into sustainable synthetic aviation fuels in one step 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 is an attractive route, which is at pilot plant stage via three step catalytic conversions. One step catalytic conversion of ethanol into branched or cyclic hydrocarbons with a carbon number of around 12 as aviation fuels is not achieved yet. This project aims to achieve this.

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.

Engineering and Technology - Mechanical, Biomedical and Design Engineering Department

Autonomous Systems, Control Engineering, Automotive, Smart and Sustainable Manufacturing, Energy Management, Cyber-Physical Production System, Digital Twin, Sensors, Reinforcement Learning, Biodegradable Surgical Implants, Neuroscience, Bioengineering, Functional Connectivity, Brain And Muscle Dynamics, Assistive Living, Real-Time Monitoring, Internet of Things (IoT), Internet of Medical Things (IoMT), Remote Monitoring, Sustainable Energy And Transport, Low Carbon Fuels, Advanced Combustion, Emissions, Engine Performance, Photonics Technologies, Ophthalmology, Optometry, Vision Science

Ethical Trajectory Planning Algorithms for Highway Autonomous Driving

Dr James E. Pickering (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Jian Wan (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)

Project Summary, Aim and Objectives:

The PhD focuses on the development of an ethical model-to-decision (EM2D) framework for autonomous vehicle (AV) trajectory planning algorithms. The EM2D approach will evaluate the AV's risk during normal driving. It is proposed that an AV's risk shall be determined based on physical properties (i.e., masses, velocities, and trajectories) and predicted outcomes (i.e., probability of a collision and injury severity of those involved based on crashworthiness data and collision modelling). Based on the AVs risks going beyond an acceptable level, algorithms will be developed that provide ethical theories to provide a fair distribution of risks for all road users. If an unavoidable collision event is detected, the EM2D approach is expected to mitigate the collision scenario, e.g., steering into the path of least severity and loss to society. Initially the algorithms will be developed using MATLAB and Simulink and then tested in real-time using CarMaker.

Knowledge and skills required in applicant:

Prospective candidates will be judged according to how well they meet the following criteria: • BEng and/or MSc/MEng in engineering, computer science, control engineering, software engineering and/or mathematics, etc. A control engineering education and research background is preferred. • Excellent English written and spoken communication skills.

Digital twin-enabled intelligent energy management for manufacturing systems towards Smart and Sustainable Manufacturing

Dr Chao Liu (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Prof Yuchun Xu (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Prof Tony Clark (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

The increasing energy costs and environmental issues have raised an urgent need to improve energy efficiency across all sectors. In the manufacturing industry, intelligent energy management of manufacturing systems has therefore become an urgent, critical, and challenging task. This PhD project aims to investigate a novel approach to address this challenge, i.e., digital twin-enabled intelligent energy management for manufacturing systems. The Festo Cyber-Physical Factory located in the Greater Birmingham & Solihull Institute of Technology (GBSIoT) will be used as the experimental platform for this project.

Three major objectives of this PhD project are to: 1) Apply IoT techniques to achieve efficient energy data collection, communication, analytics, and storage, 2) Model an energy-focused digital twin to simulate, monitor, and control the energy behaviours of the factory, and 3) Apply novel AI methods (such as deep reinforcement learning) to optimise the energy efficiency and achieve intelligent energy management of the factory.

Knowledge and skills required in applicant:

Applicants should have a solid academic background in the related subjects, including smart manufacturing, mechanical engineering, advanced manufacturing, automation and control engineering, electromechanical engineering, computer science, energy engineering, etc. Knowledge and skills of smart manufacturing technologies, energy modelling, machine learning, deep learning, python programming, data communication and analytics are preferred.

A reinforcement learning approach to autonomous sailing for monitoring water quality in reservoirs

Dr Jian Wan (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr James E. Pickering (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Prof Yuchun Xu (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)

Project Summary, Aim and Objectives:

This PhD project aims to develop systematically a reinforcement learning approach to sailing operations that enables the sailboat to continuously learn to sail better and better for the task of water quality monitoring in a reservoir. The project has three main objectives: the first objective is to explore and develop novel reinforcment learning algorithms in the context of autonomous sailing and water quality monitoring; the second objective is to build and train an autonomous sailboat with the developed reinforcement learning algorithms through sailing operations at a local reservoir; the third objective is to monitor water quality at a local reservoir reliably from a cloud platform by deploying the trianed sailboat to the reservoir. The project will involve both theoretical simulations and experimental tests. .

Knowledge and skills required in applicant:

The prospective applicant is expected to have a BEng and preferably a MSc/MEng in control engineering, robotics, artificial intelligence, mathematics, etc. The applicant is also expected to be familiar with or be willing to learn MATLAB and Python programming. Hands-on experience on sensors and robotics is also preferred.

Finite-element Based Optimisation of Biodegradable Fracture Plates for Better Bone-Healing

Dr Ali Jabran (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Anisa Mahomed (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department
Prof Chris Peach MD FRCS (The OrthTeam Centre)

Project Summary, Aim and Objectives:

Over 170 million new bone fractures cases occurred globally in 2019 alone. Metal plates are implanted to stabilise and aid the bone-healing process. However, they are permanently left in body, leading to long-term complications such as screw-loosening and bone resorption via stress-shielding. These often necessitate revision surgeries, adding burden to NHS and negatively impact patients' quality of life. Therefore, biodegradable plates have been developed in recent years that are absorbed after a certain period. However, current biodegradable plates lack mechanical strength and stability which limits their mass adoption. This project aims to develop novel biodegradable plates with enhanced mechanical and bone-healing properties.

Finite-element models simulating plate degradation and bone-healing phenomena will be developed and validated using in-vitro mechanical tests. These models will be used for optimising plates' material and design for better mechanical performance and fracture-healing and degradation properties. Optimised designs will be manufactured and mechanically tested for validation.

Knowledge and skills required in applicant:

Experience in finite element analysis (FEA), mechanical design and manufacturing in general. Experience in FEA and FEA-based optimisation and manufacturing of medical devices would be desirable, as well as knowledge of the clinical background of bone fractures.

Corticomuscular networks and sensory-motor reconfiguration in perturbation-based balance assessment

Dr Antonio Fratini (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Surej Mouli (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Prof Stefano Seri (Birmingham Women's and Children's Hospital NHS Trust)

Project Summary, Aim and Objectives:

Controlling posture while ensuring body stability is a key task of the central nervous system (CNS), but fundamental questions are however still open. Recent research revealed a more articulated picture of the neuromuscular underpinnings of bipedal stance involving the interaction and adaptation of the CNS along with the complex network of skeletal muscles and sensorimotor inputs. This project aims at identifying the neuromuscular signature of balance control across age-groups in perturbation-based balance tasks via advanced electrophysiology response analyses. The successful candidate will:

• Assess the contribution of different sensory pathways through perturbations of vestibular, visual, and somatosensory systems.
• Map the connectivity patterns of brain-muscle networks supporting postural control across age groups, using high-density electroencephalography (HD-EEG) and source reconstruction algorithms.
• Identify neuromuscular signatures of balance control via corticomuscular and corticospinal analysis and map, anatomical muscle network (AMNs) changes.
• Investigate sensorimotor response reconfiguration strategies to improve balance control.

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., python, MATLAB). Aston is committed to the principles of the Athena SWAN Charter, and we pride ourselves on our vibrant, friendly and supportive working environment.

Acceptance and Quality of Service Evaluation of the Internet of Medical Things (IoMT) to monitor, assist and protect the elderly.

Dr Surej Mouli (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Antonio Fratini (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Prof Stefano Seri (Birmingham Women's and Children's Hospital NHS Trust)

Project Summary, Aim and Objectives:

The Internet of Things (IoT) is one of the most disruptive technologies enabling ubiquitous and pervasive computing, with a predicted 27 billion internet-connected devices by the end of 2025. With the advancements in sensor technologies and connectivity, the medical industry is evolving with high-end products that allow real-time data acquisition for meaningful analysis and applications.
Aim: To develop and evaluate the acceptance, usability and quality of service of a secure and intelligent Internet of Medical Things (IoMT) platform to monitor wearable sensor data in real-time for improved assistance and safety of the elderly.
Objectives:
• To develop a wearable data acquisition platform and base station to analyse and interpret the acquired sensor data for real-time alerts and support.
• To use statistical methods and AI to recognise anomalies in the acquired data for decision-making.

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, programming and signal processing skills, microcontroller-based design, experimental analysis, basic programming e.g. MATLAB/Python.

Development and integration of a hybrid fuel cell electric powertrain system for automotive application.

Dr Tabbi Wilberforce Awotwe (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Jose Ricardo Sodre (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Amirpiran Amiri (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

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.

Knowledge and skills required in applicant:

The candidate should 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.

Development of Ammonia Combustion Strategies as Green Fuel for Marine Decarbonisation.

Dr Abul Hossain (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)

Dr Tabbi Wilberforce Awotwe (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Gareth Griffiths (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:

Decarbonisation of shipping industry is very crucial to reduce the greenhouse gas emissions in the environment. Use of low carbon fuels could play a big role to decarbonise the shipping industry. Ammonia as hydrogen carrier is a potential green fuel for marine engines. However, the direct utilization of ammonia as a fuel in diesel engine applications meets obvious challenges due to poor flame stability and low combustion efficiency. Ammonia blended with other renewable fuels or as use as dual-fuelled mode using multiple injection could be a solution to solve the problem. A simulation model will be developed to optimise and develop the novel combustion strategies of the Ammonia blended fuels. The developed model will be validated by performing the experiments in the engine laboratory. The developed model would also be useful locomotives in remote areas application.

Knowledge and skills required in applicant:

Bachelor Degree in Mechanical or Chemical Engineering. Very good analytical and problem solving skills. Good background on engines and low carbon fuels. Ability to work in a multi-disciplinary environment.

Probing human vision with orbital angular momentum of light.

Prof Igor Meglinski (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Professor Stephen Anderson (Warwick Nuffield Hospital and South Warwickshire NHS Foundation Trust)

Project Summary, Aim and Objectives:

The current project will explore the applicability of using shaped light with orbital angular momentum (OAM) for detecting central visual field dysfunctions, including age-related macular degeneration and diabetic retinopathy, with immediate further transfer for routine day-to-day clinical diagnostic practice. More specifically, the metrological capability of different states of shaped light for probing retina and exploring the response of photoreceptor cells relative to OAM/helical wave fronts in respect to maximizing the visibility contrast between the object of observation and its background will be examined.

Knowledge and skills required in applicant:

Polarization, light-tissue interaction, basic knowledge of Matlab, programming and computer modeling skills, method Monte Carlo, basic optics, basic optometry, basic biology.

Informatics and Digital Engineering - Computer Sciences Department;

Machine Learning, Computational Intelligence, Bioinformatics, Multi-agent systems, Computer Vision, GIS, Air Quality, Risk Assessment, Model-based Cybersecurity, AI, NLP, HCI, Cognitive Functioning, Knowledge Graph, Software engineering, Networked Unmanned Aerial Vehicles, Cooperative Navigation, Hybrid Wireless Networks, Explainable AI, Ethics of AI, Data Bias Artificial Intelligence – AI, Natural Language Processing, Optimisation, Cybersecurity, Internet of Things, Middleware, Artificial Life, Neuroevolution, Multi-Agent Systems, Vision, , Computer Science, Energy, Medical Imaging, Deep Learning, Eye tracking, Innovative labelling, Robotics, Ethics, Roboethics, Autonomous Systems, Long-term Autonomy, Quantum Physics.

Symbolic Regression for Explainable Protein Modelling and Prediction

Dr Felipe Campelo (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Aniko Ekart (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

The exponential increase in availability of protein sequences and associated metadata has fuelled the rise of advanced data-driven approaches for a variety of applications in biology and medicine, including protein structure/function prediction and the development of new vaccines, treatments and diagnostic tests. Two major challenges remain in most machine learning approaches to protein mining: explainability and the derivation of mechanistic models that can support further theoretical insights. The key objective of this project is to develop large-scale, bespoke symbolic regression approaches for protein representation and the prediction of specific properties, with two specific goals: (1) explainable epitope prediction, aimed at informing diagnostic and vaccine development and providing researchers with biologically meaningful insights; (2) modelling and optimisation of

specific protein functions, with a particular focus on catalytic activity, aimed at supporting enzyme development in directed evolution approaches.

Knowledge and skills required in applicant:

Good Python and/or R programming skills; Knowledge of fundamentals of Machine Learning and Data Mining; Computational Intelligence and Evolutionary Algorithms. A background in Biology (or a related discipline) and Bioinformatics is desirable but not strictly required.

Modelling the behaviour and health impacts of Vulnerable Transport Modes - pedestrians, cyclists and micromobility users.

Dr Lucy Bastin (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Maria Chli (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr George Vogiatzis (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

A growing proportion of road users use active modes or micromobility solutions like eScooters, which have huge implications for safety, network priority, air quality and sustainability. You'll work with market-leading road safety analysts and a team of experienced researchers to build a detailed model of vulnerable road user behaviour. Using CCTV footage, you'll build innovative models predicting how mobility choices impact the individual and the urban system, incorporating a range of air quality data (satellites, DEFRA stations and low-cost sensors) to evaluate accuracy and assumptions of pollution models.

This project will address real-world questions, e.g:

- Calculating pollution exposure rates for pedestrians, cyclists and micromobility users.
- Characterising vulnerable user behaviour, e.g., use of crossings/mobile phones/helmets, adherence to speed limits, use of pavements
- Automation of complex junctions, to ensure safety and optimal throughput
- Predicting the properties of traffic junction designs before deployment.
- Trade-offs between efficient traffic flow and air quality..

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.

Enacting effective cybersecurity posture for at risk stakeholders towards a more secure digitised life.

Dr Ricardo Melo Czekster (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Paul Grace (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Nitin Naik (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

Despite all technological advances in cybersecurity and protective measures encircling individuals and organisations, we as society, still witness a plethora of incidents that causes damage and loss of trust in systems. Digitisation is now a norm, however, not everyone is equipped with basic cybersecurity knowledge to defend themselves against cyber threats. Sophisticated threat agents develop tailored cyber-attacks targeting vulnerable users operating high-stake software-based systems. They install malicious footholds (to exploit later), enact identity theft, usurp administrative configurations, and tweak applications exposing data or privacy of organisations and their stakeholders. This project will investigate the reasons behind these problems and seek alternatives to tackle cybersecurity measures for at risk demographics, i.e., elderly, or non-savvy end-users. It will map technological advances to combat specific cyber-attacks and propose actionable mitigation efforts to thwart current and future malicious incursions, alerting administrators and helping vulnerable stakeholders incorporating effective cybersecurity posture in their daily digital tasks.

Knowledge and skills required in applicant:

Cybersecurity methodologies, frameworks and technologies, risk assessment, programming, data analysis, critical thinking, and scientific rigour.

AI Voice Companion and Mental-Status Analyser for Socially Isolated Older Adults.

Dr Amal Htait (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Jo Lumsden (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Cristina Romani (College of Health and Life Sciences – School of Psychology)

Project Summary, Aim and Objectives:

Many studies have connected social isolation to reduced cognitive functioning and increased risk of dementia, along with a high risk of other mental health concerns such as depression and anxiety. Older adults are typically at

higher risk of loneliness and social isolation, and this could interact with and increase cognitive difficulties. Artificial intelligence combined with natural language processing approaches can be used to detect mental state changes in a speaker via changes in the tone of voice and linguistic content of their conversational interactions. As such, this multidisciplinary project aims to develop an innovative, personalised "AI Voice Companion" for older adults to (a) help combat social isolation and (b) provide a means to detect early decline in mental status (e.g., signs of dementia, signs of depression) by observing changes in the quality of daily conversations with the digital companion. This project is a collaboration between Computer Science department and Psychology.

Knowledge and skills required in applicant:

Applicants should have a strong background in computer science, especially natural language processing, and should have expertise/experience in Python or Java. They should be interested in engaging in a multidisciplinary approach to their research, to include HCI and Psychology.

Enhanced Knowledge Aware Zero-shot learning

Dr Hai Wang (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Hassan Aqeel Khan (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

Zero-shot learning (ZSL) aims to recognize objects whose instances aren't seen during training using external knowledge. ZSL plays a vital role in many real-world applications. Text, attribute and knowledge graphs are currently used to provide the auxiliary information for ZSL, but have expressiveness for many complex knowledge facts. On the other hand, some mature software modelling and formal reasoning tools have been established successfully in the past, e.g. rule languages, feature modelling languages, UMLs, and formal methods. It will be invaluable if we could leverage these existing development to provide more expressive descriptions of auxiliary information needed for ZSL.

Knowledge and skills required in applicant:

Applicants should have a strong background in computer science, especially natural language processing, and should have expertise/experience in Python or Java. They should be interested in engaging in a multidisciplinary approach to their research, to include HCI and Psychology.

.

Network-Aware Cooperative Navigation for Swarms of Unmanned Aerial Vehicles (Drones)

Dr Alexandros Giagkos (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Paul Grace (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

From surveying and surveillance missions to search and rescue operations, a swarm of autonomous, networked unmanned aerial vehicles (UAVs) capable of cooperatively navigating within dynamic environments provides tremendous advantages compared to a single vehicle, such as flexibility, fault tolerance and extended area of coverage.

UAVs are expected to connect to and maintain an ad-hoc aerial network infrastructure to communicate while autonomously controlling their flying. To achieve such behaviour, the swarm must identify and incorporate network quality feedback into its cooperative path-planning decision-making. The main goal of this project will be to design models that allow the real-time analysis of such data and to investigate the extent to which it can be used to efficiently influence the autonomous control of the swarm's navigation.

The successful applicant will join a team of researchers with expertise in robotics, AI and network engineering and participate in field trips for data collection and platform testing..

Knowledge and skills required in applicant:

A first-class or upper second-class honours degree in Computer Science, Mathematics, Electronics, Physics or related areas. The applicant should have demonstrable skills in programming.

From Equality to Equity in AI-enabled Healthcare Systems

Dr Shereen Fouad (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Jo Lumsden (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

Computer vision (a facet of AI) enables automated diagnosis of, and treatment decisions for, healthcare problems. On many occasions, however, computer vision-based tools are trained using historic images that don't represent the population for which the tool is later used. This leads to data bias and potentially discriminatory results and skewed outcomes which can hinder medical services. This raises questions related to the ethical design and use of such technologies in delivery of accessible and effective healthcare. This project aims to address this problem by introducing an ethical data validation framework for bias detection and mitigation in computer vision-based

healthcare tasks. We will use explainable, ethical AI as well as multi-tasking machine learning methods to identify skewness among data populations and address bias. The proposed method will aim to identify inequities in data, which allows for more equitable and ethical healthcare provision.

Knowledge and skills required in applicant:

A minimum of a UK First or Upper Second-Class Honours undergraduate degree in computer science related field.
Experience and knowledge in machine learning 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.

AI, Natural Language Processing, Optimisation

Dr Harry Goldingay (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Felipe Campelo (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Aniko Ekart (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

Many of the advances made in Natural Language Processing (NLP) in recent years have been enabled by large language models, such as BERT and GPT-3. Because these models have are so large, developing them is costly both financially (estimates for the cost of training GPT-3 range into the tens of millions of dollars) and environmentally (developing a large model has been estimated to cause more than 50 times the CO2 emissions that the average human does in a year). Although it is often unnecessary to train a model from scratch to achieve good performance - commonly, large pre-trained models are fine-tuned or adapted for some downstream task - this fine-tuning can still be expensive. In this project, you will develop an optimisation-based approach to fine-tuning large language models with the goal being to make the application of such models more accessible and performant and less environmentally damaging.

Knowledge and skills required in applicant:

Applicants should possess a good honours degree (1st or 2:1) in Computer Science or a related numerate discipline, good programming skills and a familiarity with Python and a demonstrable interest in artificial intelligence. Some experience with either/both natural language processing or/and optimisation is desirable, but is not required..
.

Plastic Behaviour for Social Interaction in Agent-Based Systems

Dr Chloe Barnes (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr James Borg (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Aniko Ekart (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

Artificial systems no longer exist in isolation, meaning the actions of one can have adverse effects on others. Exploring how these types of systems can take more socially-acceptable actions could enable systems in areas such as economics, traffic management, and smart cities to align actions with societal goals – not just their own. Inspired by artificial intelligence, neuroscience and biology, this project aims to explore how behavioural plasticity – like seen in natural beings – affects how artificial systems overcome environmental dynamicity for the benefit of themselves and those around them.

The objectives of this multidisciplinary project are therefore to:

a) Model and gain understanding of the types of interactions that can take place between artificial systems in shared environments, using agent-based systems,
b) Develop novel methods of employing behavioural plasticity in artificial agents
c) Develop methods to evaluate how plasticity affects agent interaction and goal-achievement, for individuals and society.

Knowledge and skills required in applicant:

Applicants should have a degree in Computer Science or related discipline, and excellent programming skills (Java would be beneficial, but not essential). A background in Computational Intelligence techniques such as employing evolutionary algorithms is advantageous, and an interest required. An interest in interdisciplinary work and in agent-based systems is essential.

Photorealistic simulators for Training Humans and AI

Dr Maria Chli (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Luis Manso (School of Informatics and Digital Engineering - Computer Sciences Department)

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 actor behaviours, 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,
(2) generating new, realistic but previously unseen scenarios to widen the experience of the trainee, and
(3) use the simulator to produce individual and groups of autonomous actors that may be deployed to effectively control features of the environment.
Working in a multi-disciplinary team of experts in AI, multi-agent systems, robotics, simulation, machine learning and computer vision, this project is co-funded by an award-winning supplier of products and services in defence and other sectors.

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.

Optimizing the electric vehicle charging network

Dr Farzaneh Farhadi (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Maria Chli (School of Informatics and Digital Engineering - Computer Sciences Department)

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 falls far below what is needed amid surging demand.
In partnership with a leading industrial partner, this project aims to grow the public charge network to the correct scale and location to meet the growing demand. As the first step, we utilize machine learning techniques to model the public's emerging charging behaviour. To develop a precise model, we also use game theory to encourage customers to share more of their data. Based on this model, we then utilize optimization techniques to provide cost-efficient network-expansion planning with optimal location and speed for EV charging stations.
Objectives:
1- Propose suitable mechanisms for eliciting customer behaviour
2- Construct consumer behaviour model
3- Develop methods to optimize the cost-reachability tradeoff for EV charging networks

Knowledge and skills required in applicant:
The successful applicant will have a strong undergraduate and/or masters 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.

GazeTrack: Innovative approaches for labelling of medical imaging data using eye tracking

Dr Hassan Aqeel Khan (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Hai Wang (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Syed Ali Khurram (School of Clinical Dentistry, University of Sheffield)

Project Summary, Aim and Objectives:
Unavailability of large training datasets is a bottleneck that needs to be overcome to realize the true potential of deep learning in medical imaging. Although digitization has increased the speed of data acquisition, manual labelling of data by hand in domains such as pathology is expensive since it requires a substantial time investment from doctors. This work will use eye gaze labelling to enhance the throughput of the data labelling process; doctors will not explicitly label data, instead eye trackers will keep track of their gaze patterns on the computer screen as they work in their normal routine. Large volumes of labelled medical image data generated in this manner will then use this data to training deep neural networks. You will use computer vision, image processing and domain knowledge to reduce noise in the data labels. You will be working with an inter-disciplinary team consisting of computer scientists and doctors.

Knowledge and skills required in applicant:
Familiarity with machine learning and data science. Some hands-on experience with Python and Deep learning. Good coding skills in at-least one of the following languages: C/C++, Java, Python, C#. An interest in medical imaging or biomedical engineering. Ability to acquire new skills quickly.

A Toolbox for Ethical Robot Design

Dr Martin Rudorfer (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Jo Lumsden (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Aniko Ekart (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:

Robots are increasingly ubiquitous in our society and AI-based systems often make decisions that affect our lives. These systems have the potential to raise major ethical concerns but are typically developed by engineers who focus on the technical complexity and problem solving, not the wider ethical dilemmas. As such, how developed solutions affect our lives and shape society often remains unchallenged. Although research on robot and AI ethics is emerging, governmental guidance and certification is typically lacking, and consequently social and ethical implications are too often only discovered once systems are live.
The aim of this project is to develop a 'toolbox' for ethical robot design that raises researcher/developer awareness of the potential ethical implications of their work and helps navigate them to mitigate risks. The objectives are to establish a taxonomy of ethical issues, identify appropriate toolbox components, and design, develop and validate them.

Knowledge and skills required in applicant:
The topic is highly interdisciplinary and involves expertise from AI, Robotics, and Ethics. An applicant should have experience in either AI or Robotics and a genuine interest in gaining expertise in ethics.

Long Term Robot Autonomy: Can AI help?

Dr Umar Manzoor (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Aniko Ekart (School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:
Robots, just like humans, require energy to function. In current mobile robots, this energy is supplied by a power store that is taken back to a base-station and charged before the robot is re-deployed. For closed systems and long-term inspection operations, it is sometimes not feasible or even possible for the robot to return to a charging station. The aim of this research is to design and develop a self-sustainable robot capable of energy harvesting from its environmental sources and utilize it intelligently. A state-of-the-art AI model will be developed which 1) given a set of tasks, calculate the tasks energy requirements and decide which tasks robot can carried out considering robot current energy level 2) constantly monitors the robot energy level while performing tasks and learns from environment, and 3) decide when to preserve / harvest energy. The potential application we are aiming is autonomous monitoring of building pipelines.

Knowledge and skills required in applicant:
A good background knowledge in Computer Science/Engineering, as evidenced by a Bachelor's or Master's degree (at a minimum of Upper Second class honours) in a relevant subject.

Adaptive Security for the Internet of Things

Dr Paul Grace (School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Nitin Naik School of Informatics and Digital Engineering - Computer Sciences Department)

Project Summary, Aim and Objectives:
Any computational device connected to the Internet can have its vulnerabilities exploited for malicious use. Securing them is hard. Yet we are connecting more and more of these systems; think of smart homes, locks, thermostats. The dynamic composition of these systems means there will be vulnerabilities that only emerge over time. There will be large numbers of unknown devices and software connecting and interacting in unplanned and unanticipated ways, leading to a greater number of emergent threats. The aim of the project is to develop and evaluate new systems software approaches to dynamically reduce the harm of these threats. Such an IoT middleware will create and maintain a runtime model that can be used to perform risk assessment@runtime. Upon identification of new risks the IoT middleware will adapt itself to deploy IoT security controls.

Knowledge and skills required in applicant:
Previous study of cybersecurity or information security. Good programming and software development skills.

Malware Detection and Classification Technique using Quantum Search

Dr Nitin Naik School of Informatics and Digital Engineering - Computer Sciences Department)
Dr Paul Grace (School of Informatics and Digital Engineering - Computer Sciences Department)
Assoc Prof Igor Yurkevich (School of Informatics and Digital Engineering - Maths Department)

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.

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

Malware Detection and Classification Technique using Quantum Search

Dr Nitin Naik School of Informatics and Digital Engineering - Computer Sciences Department)

Dr Paul Grace (School of Informatics and Digital Engineering - Computer Sciences Department)

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.

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

Informatics and Digital Engineering – Electronical and Electrical Engineering Department;

Cancer, Biomaterials, Bone, Bioactive Glass, Mobile Networks Computing, Intelligent Transport, Smart Cities, Internet of Things,

Developing Bioactive Materials for Cancer Therapy

Prof Richard Martin (School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Dr Ewan Ross (College of Health and Life Sciences, School of Biosciences)

Professor Adrian Gardner (Royal Orthopaedic Hospital)

Project Summary, Aim and Objectives:

Bone cancers are complex and difficult to treat. Tumours are surgically removed leaving large ‘holes’ in the bone which need to be repaired. Extreme care also needs to be taken to ensure cancer does not return back to the primary site and that surgical site infections do not occur, as both lead to poor patient prognosis. The aim of this project is to work with the Royal Orthopaedic Hospital in Birmingham to develop and characterise novel multifunctional biomaterials for bone cancer therapy which simultaneously address all of these issues.

The objectives include (1) developing a controlled release of anticancer toxins that will selectively kill any residual cancer cells at the surgical site whilst remaining non-toxic to the surrounding normally health tissue, (2) developing a platform to enhance bone regeneration of the surrounding area, and (3) developing materials that provide a controlled release of antimicrobial ions to prevent surgical site infections.

Knowledge and skills required in applicant:

Applicants should have a good first degree in physical or biological sciences. The project is interdisciplinary so applicants must be willing to learn new techniques. Experience of cell biology, bioactive materials, materials characterisation, oncology or microbiology would be advantageous but is not essential as full training will be given.

Cooperative Connected Autonomous Vehicles for Safe and Green Driving

Dr Zuoyin Tang (School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Dr Richard Nock(School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)

Project Summary, Aim and Objectives:

Every year more than 1 million people die on the road due to road accidents. With advances on vehicle to everything (V2X) communication and autonomous vehicles, connected autonomous vehicles (CAVs) offers huge potentials for road safety and efficiency through direct exchange of sensing and driving information. However, CAV also faces many challenges in networking, edge computing and AI robustness. This project aims to develop novel cooperative CAV technologies and safety applications to tackle these challenges. It will design enabling

communication and computing technologies (reliable 5G V2X and edge computing schemes) and safe cooperative CAV driving applications (cooperative ADAS and platooning). The project will work on the cutting-edge research of 5G networks, mobile edge computing, robust AI/machine learning and CAV technologies. A 5G V2X based CAV system testbed will be developed for evaluation and demonstration of cooperative CAV applications. The project will help improve road safety and efficiency.

Knowledge and skills required in applicant:

Knowledge of Wireless communication and networks, AI and machine learning, intelligent transport. Skills of computer programming (e.g., Python programming)

Minimum infrastructure Internet of Things (IoT) sensor networks for air quality monitoring

Dr Richard Nock (School of Informatics and Digital Engineering - Electrical and Electronical Engineering Department)
Dr Lucy Bastin (School of Informatics and Digital Engineering - Computer Sciences Department)
Prof Kate Sugden (Aston Institute of Photonic Technologies – AiPT; School of Informatics and Digital Engineering; and Electrical and Electronic Engineering Department)

Project Summary, Aim and Objectives:

Ambient Air Pollution (AAP) is an increasing problem for human health. 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, with widespread installation of such stations being 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 in addition to energy harvesting and power reduction techniques to ensure nodes can operate for as long as possible.

This work it is envisaged that a small-scale demonstration system will be installed around the campus at Aston University....

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.

Informatics and Digital Engineering – Maths Department;

Statistical Physics, Complex Systems, Mathematics, Signal Processing, Artificial Intelligence, Fluid Dynamics, Mathematics, Computer Science, Multiscale Molecular Dynamics, Hydrodynamics, Probabilistic inference, Cortical Activity, Visual Informatics, Entropy

The Relation between Complexity and Statistical Asymmetry

Dr Roberto C. Alamino (School of Informatics and Digital Engineering – Maths Department)
Dr Juan Neirotti (School of Informatics and Digital Engineering – Maths Department)

Project Summary, Aim and Objectives:

Complexity and symmetry are two fundamental concepts with deep meanings and important applications in all areas of science, from physics to biology and social sciences. Although there are several indications that the two concepts are intrinsically related, a rigorous connection is yet to be found. The aim of this project is to explore a deep connection between the concept of complexity of structures and their symmetry properties using analytical and computational techniques. The main objectives are (i) to establish a general mathematical framework for a measure of complexity through the amount of asymmetry shown by an object on average, (ii) to apply the measure to real physical systems to show it is consistent with other complexity measures and (iii) to explore the applications of the measure to real situations in applied areas as nanostructures, disease classification and whether forecast.

Knowledge and skills required in applicant:

The students are required to have a background in statistical physics and possess strong computational and analytical skills.

Constructive derivation of biorthogonal polynomials

Dr Laura Rebollo-Neira (School of Informatics and Digital Engineering – Maths Department)
Dr Jason Laurie (School of Informatics and Digital Engineering – Maths Department)

Project Summary, Aim and Objectives:

Biorthogonal polynomials (BP) challenge the traditional use of data representation using orthogonal polynomial (OP) bases due to their potential in providing better approximations at lower dimensions. This has become an increasingly important property in the modern era of big data, where data analysis and signal processing of high-dimensional data is becoming increasingly difficult and computationally expensive. The use of BP lies at the heart of the latest machine learning techniques and attains special importance in the theory of compressed sensing where it provides a new framework for data discretisation.
The aim of the studentship is to
- Derive analytical forms of classic-type BP, which can be ascertained from classic OP.
- Develop new algorithms for the construction of sparse BP bases and investigate the conditions required for suitable sparse polynomial approximation.
- Orientate the theoretical advances to benefit machine learning methodologies that rely on polynomial representation, i.e., regression, signal processing, and artificial intelligence.

Knowledge and skills required in applicant:
Strong interest and background in Mathematics.

Towards an electrified aviation using fluid dynamics

Dr Sotos Generalis (School of Informatics and Digital Engineering – Maths Department)
Dr Takeshi Akinaga (Akita University, Japan)
Prof. K. Rinoie (Tokyo University, Japan)
Dr K. Yoshida, Dr A. Nishizawa (JAXA),
Prof. H. Oyori, Dr N. Seki, Dr K. Hirakawa and Dr K. Chiaki (IHI corp.)

Project Summary, Aim and Objectives:
Aircraft climate-neutrality is an important commitment to the future society. The passenger aircraft industry has already declared its commitment to achieving carbon-net-zero emissions by 2050.
Until now, efforts have been made to improve the efficiency of engines and the use of composite materials in airframes. Further, research on electric hybrid engines is now underway via the electrification of systems. The next goal is to achieve aerodynamic drag reduction through electrification, which is also the goal of IATA's technology roadmap.
Hybrid laminar flow control is a core technology area. However, until now, such air suction devices have not been feasible due to the weight penalty.
IHI Europe Ltd has developed an ultra-high-speed motor, which provides a solution to this problem. In the future, it will be important to optimize the amount of air suction by combining it with fluid analysis to reduce dramatically dependence on fossil fuel and achieve aircraft electrification.

Knowledge and skills required in applicant:
The candidate is expected to be able to understand the basics of fluid dynamics and be able to programme in Fortran or related high performance language.

Automation of ECG analysis

Dr Juan Neirotti (School of Informatics and Digital Engineering – Maths Department)
Dr Laura Rebollo-Neira (School of Informatics and Digital Engineering – Maths Department)

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 aims of the project are to
- Develop a principled approach for modelling, interpreting, and classifying heart beats in a ECG record.
- Dedicate techniques for subspace selection to tackle the problem of automatic diagnosis of heart anomalies.

Subspace selection for 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 idea of this project is to develop a classification framework based on these features, using machine learning and neural network techniques.

Knowledge and skills required in applicant:
Strong Mathematics and Computational Background. An interest in Machine Learning

Hybrid multiscale atomistic/hydrodynamic description of liquid systems

Dr Dmitry Nerukh (School of Informatics and Digital Engineering – Maths Department)
Dr Amit Chattopadhyay (School of Informatics and Digital Engineering – Maths Department)

Dr Igor Yurkevich (School of Informatics and Digital Engineering – Maths Department)

Project Summary, Aim and Objectives:

One of the most accurate simulation methods for liquids is Molecular Dynamics (MD) which solves Newtonian equations of motion by applying classical phenomenological inter-particle forces. However, such modelling of biological liquid systems is very resource demanding because of large number of water molecules. It is possible to increase the simulated times by representing water as a continuum in non-critical regions. The goal of this study is to develop and improve previous models based on combining the atomistic MD with the continuum hydrodynamics theories and deriving such hybrid equations for the dynamics of atoms that preserve mass and momentum. The approach allows investigating simultaneously processes at biologically relevant space and time scales which provides unique opportunities for studying biologically and medically crucial phenomena such as, for example, meso- and macroscopic transport of viruses combined with the molecular specificities of their interactions at the microscale with the cell membrane and organelles.

Knowledge and skills required in applicant:

A MSc degree in Physics, Applied Mathematics, or a related discipline is preferred, as well as a strong background in computational methods. In particular, students with a specialization in numerical modelling and multi-scale modelling are encouraged to apply. The ideal candidate has excellent scientific skills with a research-oriented attitude.

Information and functionality in cortical neuroal networks

Prof David Saad (School of Informatics and Digital Engineering – Maths Department)

Professor Rhein Parri (Aston Pharmacy School – Pharmacology & Translational Neuroscience Research Group (PTNRG))

Project Summary, Aim and Objectives:

The project aims at analysing cortical firing data of human neuronal tissue, grown from stem-cells, for obtaining insight into the emerging structure and neuronal learning patterns. While two-dimensional tissues will be studied as well, emphasis will be given to the study of three-dimensional organoids that are believed to show greater functional similarity to actual brain tissues. Its objectives are: (a) inferring the emerging inter-neuronal topology, interaction-strength and functionality; (b) deriving the resulting neuronal-tissue information content for given stimulation; (c) the presentation of network activity in an intuitive and informative way. Methods to be used include concepts from probabilistic inference, machine learning, information theory and visual informatics. This complements work done under the EU project NEU-CHiP and in collaboration with Rhein Parry from HLS. Data will be provided by our HLS collaborators as well as international collaborators from the University of Barcelona and will include emulator-generated data and in-vitro recordings."

Knowledge and skills required in applicant:

Exact-science undergraduate degree, particularly physics or mathematics. Strong mathematical and computational skills are essential. Background in probability and statistics, statistical physics, information theory and neuronal networks would be an advantage.

Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department;

Energy, Sustainability, Electrochemistry, Polymers, Materials, 2d Nanomaterials, Pollution Treatment, Chemical Vapour Deposition, Metal Compounds, Polymerisation, Polymer Chemistry, Chemical Engineering, Catalysis, Biomaterials, Stem Cells, Cultivated Meat, Tissue Engineering, Electrospinning, Water Purification, Protein, Polymer, Membranes, Computational Fluid Dynamics (Cfd), Fluid Mechanics, Fluid Dynamics, Fluid Flow Simulation, Bioenergy, NMR, Spectroscopy, Hydrogels; Antimicrobials; Drug Delivery

Next generation gel electrolytes for renewable energy storage

Dr Matt Derry (School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)

Dr Zoran Visak (School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)

Professor Paul Topham (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department

Project Summary, Aim and Objectives:

Global energy consumption is rising daily at an astronomical rate. In 2020, we used 154,620 TWh worldwide, which was more than double the amount consumed in 1978 and over six times that used in 1950. Alarmingly, renewable energy still only supplies ca. 16% of our energy demands, and it is projected that renewables will deliver only ca.

20% of global energy in 2040. This must change if we are to overcome global warming.
The biggest barrier to the uptake of renewable energy is the inherent intermittency of power production and the lack of scalable methods of storing electrical energy. Thus, there is a need to identify new solutions for sustainable energy storage. This project will develop next generation gel electrolytes for sustainable energy storage devices such as metal ion batteries and supercapacitors.

Knowledge and skills required in applicant:
Applicants should have: An honours degree (1st Class or 2:1 minimum) in chemistry or related subject; Demonstrable experience working in a laboratory environment; A strong interest in developing synthesis protocols and formulating functional materials; A willingness to learn new experimental and analytical techniques.

Aerosol assisted chemical vapour deposition (AACVD) of 2D transition metal dichalcogenides for aqueous pollutant degradation

Dr Stephen Worrall (School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)
Dr Vesna Najdanovic (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:
Treating polluted water is increasingly urgent as concerns about water quality grow and catalytic degradation is attracting significant interest. 2D transition metal dichalcogenides (TMDC) show significant promise but how best to synthesise these materials effectively is a significant challenge. Aerosol assisted chemical vapour deposition (AACVD) possesses many advantages as it naturally yields materials as thin, high surface area coatings on glass supports which are ideal for thermocatalysis/photocatalysis.
AACVD can produce certain TMDC but the more reactive diselenides (TMDSe) and ditellurides (TMDTe) have proved elusive. Preliminary data indicates this barrier may have been overcome but research is required to verify and optimise. Furthermore, electrocatalytic applications could be realised if conductive glasses could be utilised as substrates which this project will also investigate.
Objectives:
1) Utilise AACVD to synthesise TMDSe/TMDTe on conductive glasses for the first time.
2) Quantify the efficacy of materials from 1) for the catalytic degradation of pollutants..

Knowledge and skills required in applicant:
Knowledge/experience of inorganic materials, chemical vapour deposition and electrochemistry. Basic skills in synthetic and analytical chemistry required.

Design and synthesis of metal-based catalysts for carbon dioxide/epoxide co-polymerisation to yield biodegradable polymers

Dr Petra van Koningsbruggen (School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)
Dr Qingchun Yuan (Energy and Bioproducts Research Institute - EBRI)

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.

Optimisation of scaffolds for the bioprocessing of lab-grown meat

Dr Eirini Theodosiou (School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)

Professor Paul Topham (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department
Dr Ewan Ross (College of Health and Life Sciences, School of Biosciences)

Project Summary, Aim and Objectives:
From goldfish meat designed to feed astronauts in space, to chicken nuggets served in Singapore, cultivated (or lab-grown) meats have come a long way since their inception two decades ago. Industry, academia and legislative bodies are working together to bring these new products to the global market and alleviate the harmful effects caused by intensive farming and the livestock industry on public health, the environment and animal welfare. The lab-grown meat concept involves taking cells from the animal and growing them in a bioreactor using scaffolds that will provide the 3D environment for their expansion and differentiation. However, a lot of work still needs to be done to make it an affordable and sustainable option and ultimately achieve consumers' approval.
This project aims to create an edible scaffold that will replicate the natural surroundings of cells, by providing them with the necessary mechanical, biochemical and biological cues for tissue development.

Knowledge and skills required in applicant:
This is an interdisciplinary research project and the student will be working at the biomaterial/engineering/life science interface. A good first degree in science such as Materials, Stem cell biology, Biomedical science, or engineering such as Bio/Chemical engineering will be appropriate. Students with research experience in subjects above are preferred.

Bioinspired membranes for water purification

Professor Paul Topham (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department
Dr Matt Derry (School of Infrastructure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)
structure and Sustainability Engineering – Chemical Engineering and Applied Chemistry Department)
Dr Alan Goddard (College of Health and Life Sciences, School of Biosciences)

Project Summary, Aim and Objectives:
Polluted water is a complex global socioeconomic issue, affecting human and animal health, and impacting industries such as agriculture and fishing, recreational activities and transportation. Indeed, the World Health Organisation (WHO) estimates that contaminated water causes up to 500 million deaths per year. Thus, the selective removal of harmful impurities is essential to establish safe water supplies. This is a fundamental societal challenge hindered by reliance on traditional physicochemical separation methods.
In this project, which benefits from direct industry involvement, you will take inspiration from nature to develop artificial membranes to remove and isolate specific water pollutants with exquisite specificity and the ability to concentrate the molecules of interest. Sitting at the interface of chemistry and biology, you will develop the synthesis of novel polymers to facilitate extraction of active membrane proteins that provide exquisite molecular specificity for superior next generation water purification technologies.

Knowledge and skills required in applicant:
Applicants should have: An honours degree (1st Class or 2:1 minimum) in chemistry or biochemistry; Demonstrable experience working in a laboratory environment; A strong interest in developing synthesis protocols and biological processes; A willingness to learn new experimental and analytical techniques.
.

Computational modelling of concentric fluid flow

Dr Qian Xu (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department
Dr Jiawei Wang (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:
In laminar concentric fluid flow pipe, the outside fluid can be considered as thin, concentric cylindrical shells with each shell having a uniform velocity. This study will focus on the concentric fluid modelling of a Newtonian fluid (outside layer) with a Power Law fluid (inner layer). The student will start by applying simple Navier-Stokes equations with specified boundary conditions. When mathematical solutions are obtained, the student can use CFD ANSYS to generate fluid flow patterns. The study aims to explore the shear stress and shear rate impacts on concentric fluid flow patterns and hence relevant fluid devices.

Knowledge and skills required in applicant:

At least a 2:1 class Undergraduate degree which contain modules of Engineering mathematics and Fluid dynamics, know how to use at least 1 programme simulation language (Matlab, Python, CFD, Mathematica, C, C++, JAVA, etc.)

Benchtop NMR Tools for the Characterisation of Bio-oils

Dr Robert Evans (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department

Dr Scott Banks (Energy and Bioproducts Research Institute - EBRI; School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:

The use of biomass waste is one possible solution for the development of sustainable energy platforms. However, biomass consists of long, tough carbohydrate and lignin chains, which makes further use limited. Such chains can be broken down by destructive heating, or pyrolysis, into a thick, tar-like oil. These oils are mixtures of many dozens, if not hundreds, of different compounds: not only alkanes but also oxygen-containing species such as alcohols, aldehydes, carboxylic acids, guaiacols, and water. The analysis of such complex mixtures is not simple.
In this project, we aim to improve the analysis of bio-oil samples by developing quantitative nuclear magnetic resonance (NMR) -based methodologies for their analysis. Derivatised bio-oil samples allow for sub-sets of the chemical content to be analysed. Low-field, or benchtop, magnetic resonance spectrometers are an attractive alternative to the standard superconducting spectrometers by being smaller, cheaper and not reliant on supplies of cryogens.

Knowledge and skills required in applicant:

Applicants should have, or be about to obtain, a good First or Upper Second class honours degree in Chemistry or a closely related subject. Prior experience in experimental NMR and good practical skills would be desirable.

Novel Antimicrobial Nanoparticle Complexes

Dr Anisa Mahomed (School of Infrastructure and Sustainable Engineering - Chemical Engineering and Applied Chemistry Department

Prof Brian Tighe (School of Infrastructure and Sustainability Engineering - Chemical Engineering and Applied Chemistry Department)

Project Summary, Aim and Objectives:

Antimicrobial resistance (AMR) infections cause 700,000 deaths worldwide per annum, and this is predicted to rise sharply to 50 million by 2050. AMR has primarily been overcome by the discovery of new drugs however the number of antibacterial agents approved in recent times are not sufficient to challenge the rise of AMR. There is an imminent need to prolong the lifespan of current antimicrobials. Silver nanoparticles play increasingly important roles as versatile antimicrobial agents for medical products, such as wound care and personal care. Polymers can be used as stabilisers and to influence the antimicrobial characteristics. This project will involve the fabrication of polymer-stabilised silver nanoparticles. The polymeric shell can be controlled by environmental factors (e.g. pH) during the synthesis. The effect of formation conditions on antimicrobial activity will be assessed, and the resultant structures will be characterised using techniques such as dynamic light scattering and scanning transmission electron microscopy.

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. Ideally have work experience.

Infrastructure and Sustainability Engineering – Civil Engineering Department

Construction/Manufacturing Informatics, Construction Management and Engineering, Construction/Manufacturing Ergonomics, Health And Safety, Wearable Sensors And Robotics, Bio-Inspired, Ground Improvement, Sustainable Infrastructure, Finite Element Analysis, Experimental Modelling, Green Infrastructure, Reducing Carbon Emission, Civil Engineering, Infrastructure Monitoring, Structural Health Monitoring, Sensing, Building Information Modelling, Digital Construction

Blockchain-based digital twin data management platform for work-related risk assessment in construction

Dr Maxwell Fordjour Antwi-Afari (School of Infrastructure and Sustainable Engineering - Civil Engineering Department)

Prof Yuchun Xu (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Chao Liu (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)

Project Summary, Aim and Objectives:
Construction workers are frequently exposed to various ergonomic risk factors, which may lead to developing work-related musculoskeletal disorders (WMSDs).
Recently, advanced smart technology approaches have been demonstrated to identify potential work-related risks in construction. However, it is challenging to collect and manage different advanced smart technology approaches within a digital twin platform for efficient and secure data capture, data storage, and data accuracy.
Therefore, this proposed project aims to develop a closed-loop digital twin and blockchain platform by integrating advanced smart technology approaches, and data mining techniques for improved ergonomic risk assessment. The research objectives of the proposed project include: (1) To develop a rational framework of digital twin and blockchain technology for privacy protection, cloud storage, and exchange information for ergonomic risk assessment; and (2) To test and validate the proposed blockchain-based digital twin data management system on a real-world construction site. .

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).
.

Bio-Inspired materials for ground engineering

Dr Moura Mehravar (School of Infrastructure and Sustainable Engineering - Civil Engineering Department)
Prof Mujib Rahman (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Prof Patricia Thornley (Energy and Bioproducts Research Institute - EBRI)

Project Summary, Aim and Objectives:
The aim of this research is to investigate the use of novel bio-inspired materials in ground engineering and earthwork construction. This project focuses on understanding mechanical response of geo-structures built with bio-inspired materials and assess the impacts of their use on sustainability, life-cycle and resilience of earthwork construction.
The research objectives (ROs) are to:
- Design and conduct a series of geotechnical and chemical experiments to characterise physical and mechanical behaviour of the ground containing the novel bio-inspired materials
- Develop a novel approach to engineer mechanical behaviour and response of the bio-inspired materials to improve mechanical properties of the ground
- Develop a series of finite element modelling of bio-inspired engineered geo-structures (e.g., embankment) and investigate their long-term performance under different loading and environmental conditions
- Assess sustainability and life-cycle of the novel materials as an alternative raw material to conventional earthwork construction materials e.g. quarry sourced sands.

Knowledge and skills required in applicant:
Civil/Geotechnical Engineering, Mechanical Engineering, Chemical Engineering. Preferred skill requirements include knowledge/experience of standard geotechnical experiments and finite element analysis (COMSOL Multi-physics).
.

Digital Twins for bridges reinforced with Fibre Reinforced Polymers (FRPs)

Dr Nikolaos Tziavos (School of Infrastructure and Sustainable Engineering - Civil Engineering Department)
Prof Mujib Rahman (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)
Dr Dimitra Achillopoulou (James Watt School ff Engineering, University of Glasgow)

Project Summary, Aim and Objectives:
The increased demands towards sustainable structural solutions together with the need for continuous monitoring of structures under the threat of climate change requires the digitisation of strengthening techniques for existing structures. The use of fiber-reinforced polymers (FRPs) is an ideal solution, combining enhanced mechanical properties with the low carbon footprint and the excellent performance in corrosive environments. The main objective of the project is to investigate the integration level of FRPs to concrete substrates and their durability under extreme conditions. The project will investigate the potential to install sensors (fibre optics) within the FRP

matrix itself, to monitor strains and characterize crack propagation for life (digital twin). Pilot application of the model material will make use of knowledge gained from numerical modelling (process and structural) and additional feeding-in of real sensor data from bridges. The ultimate goal is to predict the integrity of the strengthened elements and report their condition at the end of their service life.

Knowledge and skills required in applicant:
Structural Engineering, Abaqus or equivalent, Experience with laboratory testing (Concrete and FRP).

Improving construction productivity through the applications of digital construction

Dr. Tala Kasim (School of Infrastructure and Sustainable Engineering - Civil Engineering Department)
Prof Mujib Rahman (School of Engineering and Technology - Mechanical, Biomedical and Design Engineering Department)

Project Summary, Aim and Objectives:
One of the main goals for digital transformation in construction sector is to improve productivity. Despite increasing adoption of digital tools in the sector, there is no clear evidence on continuous productivity improvement. This PhD research will explore in depth the main factors that are prohibiting digitalisation. The aim of the project is to develop a digital system for performances based tracking of construction activities and to examine its correlation with productivity.
The research is in line with the UK government strategy to support the development of innovative solutions comprising the use of Smart technologies as a mechanism for faster project delivery, reduce cost and minimise emissions.
The project will not be limited to Building, it has a room for implementation in infrastructure projects.

Knowledge and skills required in applicant:
Typical applicant will have a background in Civil Engineering or a relevant degree in the built environment. Candidate need to demonstrate understanding Digital Construction and BIM. Computational skills and IT background are useful to undertake the research project

Infrastructure and Sustainability Engineering – Engineering Systems and Supply Chain Management

Traffic Congestion, Transport, Emissions, Charges, Cities, Supply Chains, Control Theory, Metasystem, Optimisation, Upscaling, Renewable Energy Supply Chains, System Dynamics, Supply Chain Disruptions, Digitalisation, Resilience, Digital-Twin Capability, Digital Transformation, Sustainable, Big Data, Block Chain, Supply Chain 4.0,

Development of computational tools and forecasting models to analyse the relationships between traffic congestion, charges and greenhouse gas emissions in cities and urban areas.

Dr Marin Marinov (School of Infrastructure and Sustainable Engineering - Engineering Systems and Supply Chain Management Department)
Dr Brian Price (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)
Dr Guilhermina Torrao (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)

Project Summary, Aim and Objectives:
Traffic congestion is the prime source of air pollution in urban and sub-urban areas as it increases emissions, deteriorates air quality and degrades the environment. The effect of traffic congestion on economic, environmental and social development has been devastating. To change this situation imactful measures like traffic congestion charges and clean air zones have been introduced to reduce the use of private car and limit the number of heavy good vehicles (HGV) entering the cities. As these measures are new, the relationships between traffic congestion in urban areas, clean air zones and congestion charges have not been understood.
This project will develop computational tools and forecasting models to analyse the relationships between traffic congestion, charges and greenhouse gas emissions in cities and urban areas. The successful applicant will work towards developing workable interventions to effectively relieve traffic congestion, reduce GHG emissions in the city and improve the environment..

Knowledge and skills required in applicant:
The successful applicant should have a first class or upper second class honours degree or equivalent qualification in [Engineering Management, Transport Management and Systems Engineering Design, Supply Chain Management, Logistics, Computing].
Preferred skills include knowledge/experience of [Transport Systems, Modelling, Engineering Management, Logistics and Supply Chain; Industrial Engineering; Urban Studies, Transport Planning, Systems Design;…

A control theoretic approach to study the supply chain metasystem transition.

Dr Christos Papanagnou (School of Infrastructure and Sustainable Engineering - Engineering Systems and Supply Chain Management Department)
Dr Hing Yan Tong (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)

Project Summary, Aim and Objectives:

This project aims to examine modelling and control of developing supply chains into a metasystem. These systems appear in the presence of disruption or when transitioning to a different state. Recent examples (e.g., the break out of Covid-19, the crisis in Ukraine) have stressed the necessity to understand the changes in energy dynamics of supply chain metasystems. The implementation of an additional control mechanism to study the dynamic behaviour and performance of the supply chain system poses a new challenge, which involves the development of new types of controllers. These controllers will be designed to (i) study the dynamics of the supply chain control system and evaluate instability phenomena (e.g., bullwhip effect) (ii) appraise the transition of the evolutionary supply chain metasystem by measuring the level of evolution dynamics, (iii) examine optimisation control methods by investing on optimal information transmission and (iv) explore networked control structures and estimation.

Knowledge and skills required in applicant:

The applicant should have basic knowledge of supply chains and logistics. To comfortably work on this project the applicant should be familiar with the concept of systems, and control engineering/theory. The applicant is also expected to have a basic understanding of linear algebra, differential equations and calculus.

Upscaling of renewable energy supply chains: A network-aided system dynamics approach

Dr Evanthia Thanou (School of Infrastructure and Sustainable Engineering - Engineering Systems and Supply Chain Management Department)
Dr Dimitra Kalaitzi (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)

Project Summary, Aim and Objectives:

There is a well-expressed need for more research and support on net-zero innovation from a whole energy system perspective to accelerate commercialisation and help enable contributions to climate change. Therefore, the speed and the scale of development of renewable energy supply chains is a top priority to facilitate the energy transition. The aim of this project is to investigate the renewable energy supply chains from a systems thinking perspective. The objectives are:

i. To identify design elements and distinctive attributes of renewable energy supply chains
ii. To evaluate and assess the challenges involved in renewable energy supply chains
iii. To develop a model that will support the upscaling of renewable energy supply chains..

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 with a 60% or higher weighted average in Supply Chain Management, Logistics, Business, Operations Management, or other relevant area. Preferred skill requirements include: industry experience on data science, renewable energy, supply chain.

The role of Digital Twins in Improving Supply Chain Resilience

Dr Dimitra Kalaitzi (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)
Dr Evanthia Thanou (School of Infrastructure and Sustainable Engineering - Engineering Systems and Supply Chain Management Department

Project Summary, Aim and Objectives:

The pressure on supply chains remains unrelenting. Pandemics such as the Covid-19, natural disasters, price fluctuations, cyberattacks are some of the many and diverse events that lead to supply chain disruptions. Digital twins can be key enabler of supply chain resilience as they can support end-to-end visibility and traceability. However, the technology remains underutilised as we know very little about the use of digital twins in supply chains. There is lack of knowledge when it comes to what kind and how the capabilities of digital twins can support or hinder supply chain performance and resilience. Hence, a study to evaluate the critical success factors and the capabilities needed to support digital twin implementation would be valuable both theoretically and practically. This project will also evaluate obstacles for implementing digital twins in supply chains and assess the impact of digital twin on supply chain resilience, organizational performance, and competitive advantage.

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 with a 60% or higher weighted average in Supply Chain Management, Logistics, Business, Operations Management,

or other relevant area. Preferred skill requirements include industry experience on data science, simulation, statistics, supply chain.
.

Digital and Sustainable: A comprehensive outlook of disruptive technologies enabling supply chain digital transformation

Dr Muhammad Azmat (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)
Dr Brian Price (School of Engineering and Technology - Engineering Systems and Supply Chain Management Department)

Project Summary, Aim and Objectives:

Temporary disruptive events have low probability and high impacts, which are difficult to anticipate and imply a certain level of turbulence across the whole supply chain. Such events can lead to supply chain disruptions resulting in organisational losses (Financial, customers etc.). Through the digital restructuring of the supply chains and employing the resources effectively, firms can achieve a higher degree of resilience in their processes and keep the systems capable of dealing with the changes in the external and internal environments. Digital systems and approaches bring a technology-driven (such as Block Chain, Internet of Things, logistics 4.0, Supply Chain 4.0 etc.) proactive mechanism for dealing with the fluctuations in the external environment. With its blended (mix method) approach, this research addresses how modern technology can adapt in this context and be resilient to disruptions. Disruptions due to Brexit, COVID-19, and the war in Ukraine serve as a few recent examples..

Knowledge and skills required in applicant:

Master in business or Economics or IT or Engineering; Basic knowledge and understanding of digital transformation; Self-driven & motivated to publish high quality research; Preferably prior research writing and publishing experience; Excellent knowledge of Modelling (e.g., SEM, ASEM) and Simulation Softwares; Excellent Quantitative and Qualitative methodology skills; IELTS 6.0 +.
.