Research project and supervisory team

Check detailed information by clicking each project title below:

Green Chemicals and Energy

1. Controlled Synthesis of S-Scheme-based Heterojunctions for Efficient Photocatalytic H2 Evolution and CO2 Conversion (Dr. Shahid Iqbal)
2. Controlled synthesis of 2D/2D heterostructures and mechanism of visible-light-driven S-scheme overall water splitting (Dr. Shahid Iqbal)
3. Turquoise hydrogen production from bio-methane pyrolysis targeting high-value solid carbons (Dr. Nicholas Musyoka)
4. Catalyst development for direct conversion of CO2 to methanol (thermo-catalytic reaction route)(Dr. Nicholas Musyoka)
5. Modelling of fluidised bed reactor for non-catalytic and catalytic methane reforming using chemical reactor networks and detailed kinetics (Dr. Paulo Debiagi)
6. Kinetic Modelling of Thermochemical Conversion of Municipal Solid Waste for Production of Syngas, Chemicals, Heat and Electricity Generation (Dr. Paulo Debiagi)
7. Design of Novel 2D Materials for Green Fuels (Dr. Muhammad Sajjad)
8. Surface and Interface Engineering of Two-dimensional Materials for Green Fuels via Catalysis (Dr. Muhammad Sajjad)
9. Process Design and Development (Dr. Lionel O'Young)
10. Accumulating & Controlling Mechanism of Dominant Bacteria during Particle Enhanced biological Wastewater Treatment (Dr. Yuanyuan Shao)
11. Development of a fluidization system with internal heaters for polysilicon production (Dr. Xiaoyang Wei)
12. Novel catalysts design for high-value products derived from methyl aromatic hydrocarbons (Dr. Xiaoxia Ou)
13. CO_2 hydrogenation to methane and methanol (Dr. Xiaoxia Ou)
14. C2-oriented photocatalysts design and CO_2 reduction performance enhancement mechanism (Dr. Honglei Zhang)
15. Probabilistic machine learning analysis of electrochemical data for characterization of mixed-species microbial biofilms (Dr. Enrico Marsili)
16. Simultaneous Supercritical CO2 Extraction and Sterilization for Bio-safe Edible Oils (Dr. Dongbing Li)

Intelligent Manufacturing

17. Multi-material DLP printer for fabricating programmable devices (Dr. Yinfeng He)
18. Multi-Material, Multi-Functional Device Design for Voxel- Based Additive Manufacturing (Dr. Yi Nie)
19. Innovative vibration control of electro-mechanical drive trains using active bearings (Dr. Dunant Halim)
20. Human Computer Interaction (Prof. Xu Sun)
21. Fundamental research on scalability, accuracy, robustness and interpretability of neural networks (Prof. Jim Greer)
22. Learning Guided Combinatorial Optimisation (Prof. Ruibin Bai)

Life Science and Healthcare

23. Tackling the pandemic of antibiotic-resistant infections: An artificial intelligence approach to new druggable therapeutic targets and drug discovery (Dr. Tania Dottorini)
24. To explore the genetic mechanisms of multiple pain phenotypes based on the UK Biobank cohort (Dr. Weihua Meng)
25. Wearable Optical Biosensor (Dr. Jing Wang)
26. AI Enabled Drug Discovery (Dr. Bencan Tang)

Project title	Controlled Synthesis of S-Scheme-based Heterojunctions for Efficient Photocatalytic H2 Evolution and CO2 Conversion
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Shahid Iqbal Muhammad Sajjad
Short introduction of research project	Fuel shortages and environmental problems have been substantially exacerbated by the lessening of fossil energies, such as coal, natural gas, and petroleum, as well as the considerable rise in CO2 emissions. Heterojunction engineering is urgently needed because photoinduced charge carrier recombination occurs at high rates and because the capacity of these carriers to conduct both oxidation and reduction in a single photocatalyst is restricted. The step-scheme (S-scheme) heterojunction scheme has exhibited excessive potential as a state-of-the-art photocatalytic system by accelerating the separation and carriage of photogenerated electron-hole pairs as well as obtaining high photoredox capacity. MXenes, a unique family of two-dimensional (2D) materials like Ti3C2Tx, have drawn growing amounts of research attention because of their peculiar physicochemical and electrical characteristics, which vary very dramatically from those of their bulk counterparts. For photocatalytic processes, both heterojunctions will lengthen the lifespan of photogenerated e- and h+ that are present in the appropriate band locations. The intrinsic link between the thickness of the co-catalyst (Ti3C2Tx) and the photocatalytic activities as well as the evidence of an electron-hole pair migration route using the S-scheme will also be investigated as additional possible characteristics of this research. The project's results will provide a better comprehension of the photocatalytic process and reaction mechanism in addition to the development and implementation of multifunctional numerical tools for the next research.
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Project title	Controlled synthesis of 2D/2D heterostructures and mechanism of visible-light-driven S-scheme overall water splitting
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Shahid Iqbal Mina Liu
Short introduction of research project	Overall water splitting (OWS) employing a particulate photocatalyst and solar energy, where the light energy is transformed into clean H_2 energy, is a technologically simple and cost-competitive route toward sustainable H_2 generation owing to its potential for widespread use. Limited visible-light harvesting, improper coupling of catalyst components, insufficient catalytic active sites and unraveling the sluggish charge separation for step-scheme (S-scheme) heterostructure photocatalysts remain a core challenge toward OWS. The project's goal is to design and develop a well-defined 2D/2D S-scheme heterojunction at $BiVO_4/BaTaO_2N$ interface via $Ti_3C_2T_x$ redox mediator served as to promote the surface reaction between the H_2 ($FeNiP/BaTaO_2N$) and O_2 ($Co(OH)_2/BiVO_4$) evolving components. This project will explore the intrinsic relationship between the thickness of the redox mediator ($Ti_3C_2T_x$) and photocatalytic activities. The designed heterostructures will be fabricated via the self-assembly method, characterized by spectral analyses and the first principle. The project will reveal that high-quality S-scheme heterojunction between $BiVO_4$ and $BaTaO_2N$ will play an important role in maintaining the photogenerated electron-hole pair with strong redox abilities. Moreover, the synergistic cooperation of the S-scheme heterojunction and $Ti_3C_2T_x$ will explain the enhanced photocatalytic ability and will provide additional highly exposed active sites for surface reactions.
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Project title	Turquoise hydrogen production from bio-methane pyrolysis targeting high-value solid carbons
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Nicholas Musyoka Paulo Debiagi Xiaoyang Wei
Short introduction of research project	Biogas is a promising renewable energy source and has been gaining increasing attention over the years. Previous high-level techno-economic studies reported that the feasibility of turquoise hydrogen production from biogas/bio-methane is heavily dependent on the price of the hydrogen and carbon product streams. Therefore, the main aim of the proposed study is to develop a process for producing high-value carbons that will make the biogas-based turquoise hydrogen production process more feasible and economically competitive. A novel aspect of the study will be the utilisation of pristine and modified catalytic and sorbent materials. The experimental activity will be conducted in parallel with modelling and simulation activities, using methods of detailed chemical kinetics, reactor network modelling and computational fluid dynamics. These activities are complementary in unravelling details of the process that cannot be easily measured or predicted. Importantly, the project aims to eventually advance towards fabrication of a demonstratable/customizable modular unit tailored for the pyrolysis reaction with a possibility to also employ a modified fluidised bed system for the continuous production of hydrogen from the renewable biogas feedstock.
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Project title	Catalyst development for direct conversion of CO_2 to methanol (thermo-catalytic reaction route)
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Nicholas Musyoka Mengxia Xu Paulo Debiagi
Short introduction of research project	The production of methanol and its derivatives represents a pathway for the use and storage of hydrogen produced by Renewable Energy (RE) sources such as solar photovoltaics (PV) and wind energy. Also, bearing in mind that captured CO_2 can be used as a reactant to produce methanol, the adoption of wide-scale power-to-methanol technologies can play an important role in large-scale CO_2 recycling which would serve as a promising means for combating the rising CO_2 emissions. This approach could assist many countries in meeting their greenhouse gas emission commitments. The catalytic conversion pathway of direct CO_2 hydrogenation can be achieved via various routes, which includes thermo-catalytic reaction, photo-catalysis, electro-catalysis, and bio-catalysis. Among them, the thermo-catalysis route has the most promising prospects for faster transition to commercialisation since this process has been demonstrated at huge pilot plants. However, for the process to favourably compete with the conventional syngas route, there is a need for continued development of efficient and stable CO_2 transformation catalysts. Therefore, the proposed project aims at the development of efficient and effective catalysts following two suggested approaches i.e. (i) use of mixed oxides such as $ZnO-ZrO_2$ and/or $ZnO-CeO_2$ interfaced with promoters' effects and (ii) promotional and support effects of established CuZn catalyst. Supported by experimental characterization of the catalysts, kinetic mechanism will be developed and validated. Reaction modelling will be incorporated in the study using the ideal reactor units of the OPENSMOKE++ framework in kinetically controlled conditions. For laboratory-scale reactors, the chemical reactor network NetSMOKE++ will be employed.
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Project title	Modelling of fluidised bed reactor for non-catalytic and catalytic methane reforming using chemical reactor networks and detailed kinetics
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Xiaolei Fan Paulo Debiagi Xiaoyang Wei
Short introduction of research project	Global climate crisis calls for urgent greenhouse gases (GHG) emission reduction. Carbon capture usage and storage (CCUS) technologies are promising to support the establishment of sustainable industry and economy. Dry-reforming of methane (DRM) offers a dual environmentally significant solution, by consuming two GHG in the process, and producing syngas (mixture of H_2 and CO) that serves as building blocks for green chemistry. Fluidised bed reactors (FBR) are ideal candidates for DRM, due to their favourable mixing features, near-constant temperatures and good operating flexibility. Simulation of thermochemical conversion processes provides powerful tools for process development, optimization and scale-up. In this work, we propose the numerical investigation of the DRM process in FBR implementing the state-of-the-art detailed kinetic mechanisms and chemical reactor networks. The project outcomes will allow a deeper understanding of the process and reactor dynamics, together with the development and establishment of multi-purpose numerical tools for future investigations.
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Project title	Kinetic Modelling of Thermochemical Conversion of Municipal Solid Waste for Production of Syngas, Chemicals, Heat and Electricity Generation
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Dongbing Li Paulo Debiagi Xiaoyang Wei
Short introduction of research project	Global climate crisis calls for urgent greenhouse gases (GHG) emission reduction. Energy demand worldwide is surging, which challenges the decarbonisation process and decrease of GHG emissions. About two billion tons of municipal solid waste (MSW) was generated in 2016, and management of these material is a challenge. While metals, glass and construction waste are the majority of the inorganic fraction, plastics, food waste, textile and paper characterize the majority of the organic fraction. These materials represent a hazard to human health and to the environment. The thermochemical conversion of MSW offers a dual solution: (1) waste management by consuming the materials, and (2) sustainable energy and green chemistry, for converting MSW into value-added products such as syngas, chemicals, heat and electricity. Development of thermochemical conversion technologies for MSW is challenging because of the complex and variable composition of the feedstock, which significantly affects the required pre-treatment, the heating value, the operating conditions and the products. Process simulation is an important tool to manage these complexities, providing valuable predictions to develop, control, optimize and scale-up the process. Detailed chemical kinetics are capable of giving accurate reacting system predictions, but appropriate material characterization is required. In this project, we propose an investigation of the local MSW material, aiding the definition of a model waste-fuel that will serve as the base to develop a comprehensive kinetic model for the thermochemical conversion of MSW. The project outcomes will allow a deeper understanding of the behaviour of MSW in high-temperature thermochemical conversion, together with the development and establishment of a multi-purpose numerical framework for future investigations of this topic on larger scales.
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Project title	Design of Novel 2D Materials for Green Fuels
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Muhammad Sajjad
Short introduction of research project	The search for novel catalysts for green fuel production is vital in our increasing demand for energy resources in our daily life. These catalysts enable the conversion of environmentally harmful greenhouse gases such as carbon dioxide to usable fuel such as methane and ethanol. Research and discovery into such catalyst materials that can generate green fuel with high efficiency are paramount. Two-dimensional (2D) materials have set of unique properties including high surface to volume ratio, but are not promising for catalysis due to their inertness of their surfaces. One the other hand, high-entropy 2D materials (like MXenes and transition metal dichalcogenides) have recently got attention due to their high mechanical stiffness and favourable chemical and electronic properties for catalytic applications. In addition, high-entropy materials, such as high-entropy oxides and nitrides, are highly disordered and contain several metal atoms in contrast to pristine ordered phases. The research project aims to explore such materials (focusing on high-entropy MXenes and high-entropy transition metal dichalcogenides) for their application in green fuel production. Using state-of-the-art first-principles calculations and molecular dynamics simulations, we propose an investigation of mechanical, thermodynamic stability, chemical, and electronic properties, followed by their applications in catalysis. The exploration of efficient and cost-effective alternatives to precious metal catalysts will pave the way for sustainable energy solutions and contribute to a cleaner and greener future.
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Project title	Surface and Interface Engineering of Two-dimensional Materials for Green Fuels via Catalysis
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	[Muhammad Sajjad]()
Short introduction of research project	The increasing demand for alternative energy sources, driven by the depletion of traditional fossil fuels, necessitates the development of sustainable and eco-friendly energy resources. Hydrogen, due to its abundance and clean nature, holds immense potential as a green fuel; however, conventional production methods emit CO_2, contributing to global warming. Two-dimensional (2D) materials, with their unique mechanical and electrical properties and large surface area, offer promising alternatives for electrode materials. Nevertheless, their pristine form exhibits limited catalytic efficiency. Surface and interface engineering have emerged as powerful tools to enhance the catalytic performance of 2D materials, making them viable candidates for green fuel production via catalysis. This research project aims to explore the atomic-level understanding of surface and interface engineering of 2D materials to design novel catalyst materials for green fuel production. Utilizing advanced computational methods and simulations, the project seeks to uncover strategies for enhancing the catalytic performance of 2D materials. The exploration of efficient and cost-effective alternatives to precious metal catalysts will pave the way for sustainable energy solutions and contribute to a cleaner and greener future.
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Project title	Process Design and Development
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Green Chemical Processes & Process Intensification
Supervisory Team	Lionel O'Young Kam Loon Fow Kien Woh Kow
Short introduction of research project	In separation of mixture, it is crucial to select the appropriate combination of driving forces. To achieve a safe, economical, and operable separation process, large number of feasible options will need to be studied in the design stage. Unfortunately, equilibrium data are not readily available for the system especially while developing a new processing route. In addition, it is costly to obtain such equilibrium data empirically. In this work, it is aimed to develop a robust prediction method to supply the necessary data for the above process at suitable accuracy as needed for various stages of process development. Furthermore, experiments will be designed to validate and increase the accuracy of the calculation at the given design/operation condition. In this project, successful candidates will be provided with the intensive training about process development especially in the area of separation process. In addition to experimental works, a systematic use of process modelling and machine learning algorithms will be beneficial to the optimization of the designed process. There are also opportunities for the developed method to be validated on industrial-linked projects.
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Project title	Accumulating & Controlling Mechanism of Dominant Bacteria during Particle Enhanced biological Wastewater Treatment
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Green Chemical Processes & Process Intensification
Supervisory Team	Yuanyuan Shao Dongbing Li Xiaoyang Wei
Short introduction of research project	Particle Enhanced Bio-Reactor (PEBR) has been developed by the PI's team for efficiently biological wastewater treatment, which leverages the suspended particles as the carrier to provide numerous surface area for the growing of bacteria, thus intensifying the biological treatment process and enhancing the performance of the system. The project is proposed to extent the application of this technology for the industrial wastewater containing high concentrations of COD and/or NH4-N. Ph.D. candidates will focus on detailing mechanisms of growing and accumulating of working bacteria on the surface of carriers and R&D of multi-functional particles, respectively
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Project title	Development of a fluidization system with internal heaters for polysilicon production
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Green Chemical Processes & Process Intensification
Supervisory Team	Xiaoyang Wei Yue Yuan
Short introduction of research project	Multiphase flow systems are widely used in chemical, pharmaceutical, environmental industries. However, the multiphase flow is usually highly dynamic and very complex, hindering the development of multiphase flow theory and the optimization of multiphase flow systems. In our lab, PhD students will work closely with industrial partners on multiphase flow systems, such as chemical reactors, dry powder inhalers, medicine coating, and protein recovery from liquid streams. Cutting-edge technologies, including artificial intelligence (AI), 3-D printing, high-speed camera, intrusive probes, will employed to experimentally characterize the multiphase flow. Referring to the experimental data, numerical models will be developed with workstations, servers and supercomputers. Finally, multiphase flow systems can be designed and intensified for specific industrial processes.
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Project title	Novel catalysts design for high-value products derived from methyl aromatic hydrocarbons
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Green Chemical Processes & Process Intensification
Supervisory Team	Xiaolei Fan Xiaoxia Ou
Short introduction of research project	Benzyl alcohol, benzaldehyde and benzoic acid are high-value chemicals widely using in pharmaceutical, pesticide and other industries, which are generally produced by selective catalytic oxidation of aromatic hydrocarbons. The process usually requires high pressure and high temperature, resulting in low selectivity to high-value products. In this research, novel and effective catalysts will be designed to enable high conversion of aromatic hydrocarbons with high selectivity to valuable products under milder conditions. Catalyst designs and syntheses, characterizations and systematically catalytic performance tests will be conducted, as well as mechanism and kinetic study, which will facilitate the rational design of novel catalytic formulations for selective catalytic oxidation of aromatic hydrocarbons and gain mechanistic insights of the systems for pilot test and scaling-up. The research project will develop high-performance supported catalyst for selective catalytic oxidation of aromatic hydrocarbons. Mechanism study will help to understand interactions between different components (catalyst active phase, support, promoter, oxidizing agent), and the dynamic behaviours will be clarified to rationally develop new catalytic formulations.
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Project title	CO_2 hydrogenation to methane and methanol
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Green Chemical Processes & Process Intensification
Supervisory Team	Xiaolei Fan Xiaoxia Ou
Short introduction of research project	Methane (CH_4) and methanol (CH_3OH) are key fuels and platform chemicals for many important applications. They are conventionally obtained from fossil resources such as natural gas and coal. Hence, the use of the captured CO_2 as the carbon source can be a sustainable option to produce green CH_4 and CH_3OH for sustainable development of the society. Built on our previous research findings, this project will focus on the further development of economic catalysts based on transition metals such as Ni for methanation and Cu for hydrogenation to green methanol, which will be supported by relevant in situ and kinetic studies to gain mechanistic insights of the systems for pilot test and scaling up.
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Project title	C2-oriented photocatalysts design and CO_2 reduction performance enhancement mechanism
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Renewable Energy & Energy Storage
Supervisory Team	Honglei Zhang
Short introduction of research project	Visible-light-driven conversion of CO_2 into fuels or useful chemicals is a promising methodology for solving the world crises of energy supply and the rising atmospheric CO_2 level. The reported products from CO_2 photocatalytic reduction are mainly C1 products, C2 products with higher values are sparsely reported or they are produced at ultra-low selectivity. Novel photocatalysts or catalytic system will be dedicatedly synthesized for C2 production in photocatalytic reduction of CO_2.
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Project title	Probabilistic machine learning analysis of electrochemical data for characterization of mixed-species microbial biofilms
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Green Chemical Processes & Process Intensification
Supervisory Team	Enrico Marsili Daniele Garrisi
Short introduction of research project	Biofilm electrochemistry can contribute to the resolution of mixed-species biofilms, due to its low cost, real-time and non-destructive characteristic. While biofilm electrochemistry cannot provide a final identification of each microbial species, it is in theory possible to analyse the specific signature of each microbial species using probabilistic machine-learning (PML) methods. This project aims to develop a novel method for real-time, online characterization of mixed-species biofilms using bioelectrochemical methods in combination with PML driven data analysis. The PhD student will focus on the writing of the Probabilistic Machine Learning (PML) code and electrochemical data analysis (acquired by another PhD student in our group) for the modelisation of mixed-specie biofilms. S/he would have a background in Data Science/Computer Science/Physics/Applied Mathematics/Engineering with a strong interest in Mathematical and Computational Biology. The PhD student will work closely with the other PhD student in the project to optimize the data acquisition pipeline. S/he will be co-supervised by Prof Alberto D'Onofrio, a PML and Mathematical/Computational Biology expert at University of Trieste, Italy and by Prof Daniele Garrisi, an expert mathematician from UNNC. The project might include a short-term secondment at University of Trieste for training in mathematical methods and data analysis.
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Project title	Simultaneous Supercritical CO_2 Extraction and Sterilization for Bio-safe Edible Oils
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Smart Food
Supervisory Team	Dongbing Li Enrico Marsili Yuanyuan Shao
Short introduction of research project	Woody oil tree species (such as Acer truncatum, walnut, and sea buckthorn) can produce high-end edible oils. Consumers often ingest it orally or from cold dishes, bypassing the high-temperature cooking and sterilization process. Therefore, it is extremely important to identify the potentially pathogenic microorganisms and perform sterilization treatment to improve food safety. Experiments have shown that the seed oil of Acer truncatum produced by mechanical pressing contains a considerable amount of active microorganisms, while the seed oil obtained by supercritical CO_2 extraction has a much lower amount of live microorganisms. This project begins with the identification of pathogenic microorganisms in the seed oils. The effects of various supercritical CO_2 extraction operating parameters will be investigated and the underlying mechanisms for significant sterilization will be elucidated. Improved measures to overcome the inhibitory effect of oil substrate conditions on supercritical CO_2 sterilization are then developed, establishing the optimal process conditions for simultaneous supercritical CO_2 extraction and sterilization (one-pot method). Finally, the oxidation stability (shelf life) of the oil product will be evaluated and the relationship between oxidation stability and microbial composition, enzyme composition, and activity of seed oils will be demonstrated. The successful completion of this project can provide a complete scientific theory and technical guidance for the production of woody seed oils by simultaneous supercritical CO_2 extraction and sterilization, and provide new reference information for the food safety of other vegetable oils. This project's specific research objectives are as follows: 1) To clarify the inhibitory effect of seed oil substrate conditions on the supercritical CO_2 sterilization process, its mechanism of action, and effective improvement measures; 2) To develop the simultaneous supercritical CO_2 extraction and sterilization process. The optimal technological conditions are evaluated in order to evaluate the oil product quality indicators (particularly oxidation stability), and the response mechanism between the oxidation stability of seed oil and microbial composition, enzyme composition, and activity will be clarified.
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Project title	Multi-material DLP printer for fabricating programmable devices
Programme	PhD PhD IAMET New Materials and New Equipment
Research area	Additive Manufacturing
Department or School	Department of Mechanical, Materials and Manufacturing Engineering
Supervisory Team	Yinfeng He (UNNC) Haonan Li (UNNC) Yi Nie (UNNC)
Short introduction of research project	Additive Manufacturing provides a unique opportunity to create complex geometries that can be customized for individuals. The recent voxelated manufacturing technology (also known as multi-material additive manufacturing or 4D printing) enables a new level of design and customization freedom, bringing new opportunities to a variety of applications. This project aims to develop a Digital Light Processing (DLP) based additive manufacturing system to achieve voxelated manufacturing aiming for customized medical devices. The successful Ph.D. candidate will develop a novel system with unique printing and cleaning strategy to achieve hybrid printing of polymeric/ceramic materials. This project will be carried out jointly with the University of Nottingham Centre for Additive Manufacturing (CfAM) group and the student is expected to work at CfAM UK during Year 3 (subject to the student's progress). In year 1 and 2, the student will be based at China Beacons Institute, University of Nottingham Ningbo China. We are seeking talented candidates with: • First or upper second class degree in mechanical/mechatronics or related scientific discipline • Demonstrated ability to develop precision mechatronics system and algorithm • Background with relevant packages (MATLAB,Python,LabVIEW) • A professional and self-motivated work attitude is essential
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Project title	Multi-Material, Multi-Functional Device Design for Voxel- Based Additive Manufacturing
Programme	PhD PhD IAMET New Materials and New Equipment
Research area	Additive Manufacturing
Department or School	Department of Mechanical, Materials and Manufacturing Engineering
Supervisory Team	Yinfeng He (UNNC) Yi Nie (UNNC) Ian Maskery (UNUK)
Short introduction of research project	The real potential and value of Additive Manufacturing (AM) will come from the design and Implementation areas. We will explore the development of next-generation device using our developed Multi-material DLP printers and photoreactive formulations. The Multi-material DLP printers will be applied to control the distribution of multiple polymer materials, enable macro- and micro lattice structure, and fulfil the customized shape of the device. Reliability optimization among material distribution, structural dimensions and processing parameters is to be carried out to maintain the device's durability to resist mechanical and structural damage. The successful implementation of this project will be promising for the development of various high-end bio-products for applications such as Heart, digestive tract or orthopaedic diseases treatments. This project will be carried out jointly with the University of Nottingham Centre for Additive Manufacturing (CfAM) group and the student is expected to work at CfAM UK during Year 3 (Subject to the student's progress). In years 1 and 2, the student will be based at China Beacons Institute, University of Nottingham Ningbo China. We are seeking talented candidates with: • First or upper second-class degree in mechanical/material, mathematics, physics or related scientific discipline • Demonstrated ability to design, manufacture and evaluation of devices • Background with relevant packages (CAD/CAE software) • A professional and self-motivated work attitude is necessary
Contact points	Dr. Yi Nie yi-nie@nottingham.edu.cn

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Project title	Innovative vibration control of electro-mechanical drive trains using active bearings
Programme	PhD Mechanical Engineering
Department or School	Department of Mechanical, Materials and Manufacturing Engineering
Research area	Advanced Manufacturing
Supervisory Team	Assoc. Prof. Dunant Halim
Short introduction of research project	This project is focused on addressing important challenges in achieving effective vibration/noise suppression of an electromechanical drive train, consisting of a combined electric motor and a mechanical drive train, for a wide range of advanced manufacturing and transportation applications. The noise and vibration problems in electromechanical drive trains are commonly addressed by over-engineering that leads to relatively bulkier and heavier designs. Therefore, to address the vibration and noise problems, the project aims to develop an innovative active vibration control system for electromechanical drive trains, incorporating electromechanical actuation through active bearings to suppress excessive vibration of the system. The project will cover vibration control system design which will be verified through simulation and experimental investigations. The research investigation includes the rotordynamic modelling and analysis of electromechanical drive trains with active bearings; design of active vibration control systems; and the stability analysis, performance evaluation and optimization of active vibration control systems for electromechanical drive trains. This project is expected to provide an important theoretical and practical foundation for the development of effective active vibration control of electromechanical drive trains for industrial applications.
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Project title	Human Computer Interaction
Programme	PhD Mechanical Engineering
Department or School	Department of Mechanical, Materials and Manufacturing Engineering
Research area	Human-Computer Interaction; Human Factors; Innovative Design; User Experience Research.
Supervisory Team	Prof. Xu Sun Dr. Deng Wu
Short introduction of research project	The project aims to develop a suite of intelligent data-driven approaches in the transformation of the traditional manufacturing paradigm to smart manufacturing. It could empower today's car manufacturers to adopt data-driven strategies to enhance the customer experience, ensure road safety and ultimately stand out in the fierce competition automotive market. The specific objectives include: a. Construct new data-driven models that can predict/explain the relationships between different user, task and environment variables as they relate to automated vehicle design characteristics. There has been an emphasis on how from a technological perspective the status of the driver (e.g. emotions, fatigue, motion sickness system use) can be monitored and predicted– especially in real-time. b. Develop intelligent algorithms and data warehouse technologies that researchers and practitioners can use to profile users, prepare automated vehicles (AVs) for a smooth transition between roles and calibrate user trust for AVs. c. Develop a new data-driven vehicle concept that demonstrates the ultimate user experience by showcasing the novel adaptive Human Machine Interfaces (HMIs) developed within the research theme. There is a focus is to explore how a driver profile, specifically within an automated driving context and generated based upon driver status, can be used to inform intelligent adaptations of the HMIs.
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Project title	Fundamental research on scalability, accuracy, robustness and interpretability of neural networks
Programme	PhD Electrical and Electronic Engineering
Department or School	Department of Electrical and Electronic Engineering
Research area	Machine learning
Supervisory Team	Jim Greer
Short introduction of research project	Neural network based learning has become the dominant paradigm in modern machine learning. Although the success stories of machine learning---especially deep learning---have garnered significant attention, there are fundamental challenges that must be addressed before neural networks may be deployed as reliable components in safety/mission critical systems. Some of the notable challenges include interpretability, robustness, and cost of training. To address these challenges, a systematic approach based on sound mathematical principles must be adopted. At the same time, such research must be guided by the insight obtained from practical applications of machine learning. The aim of this proposal is to study computational properties of neural networks at a fundamental level. We analyze salient aspects such as scalability, accuracy, robustness and interpretability of machine learning systems deployed in engineering applications. The proposal is part of a broader cross-disciplinary project that involves electrical engineering, chemical engineering, and material sciences. As such, this is an ideal opportunity for candidates who are interested in fundamental research which can also broaden their understanding of science and engineering by collaborating with researchers from a variety of disciplines.
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Project title	Learning Guided Combinatorial Optimisation
Programme	PhD Computer Science & Operations Research
Department or School	School of Computer Science
Research area	▪ Combinatorial Optimisation ▪ Computational Intelligence ▪ Deep Reinforcement Learning ▪ Transportation Analysis and Optimisation ▪ Big Data
Supervisory Team	Ruibin Bai Rong Qu
Short introduction of research project	Combinatorial optimisation problems (COP) have extensive real-life applications. However, most of them are NP-Hard and finding the optimal solutions is normally computationally prohibitive for large-size instances. The problems become even harder when uncertainties are taken into account to improve the practicality of the solutions. The existing approaches to tackle these types of problems can broadly be classified into analytical model driven methods (typified by mathematical programming methods) and data-driven methods (e.g. genetic programming and reinforcement learning. The former methods focus on the analytical properties of the mathematical model but may suffer from the robustness issues over uncertainties from the input data. The data driven methods often formulate the combinatorial problems as online optimisation problems and try to tackle the problem sequentially based on some policies or rules upon the realisation of random variables and the states of the partial solution at each decision point. One of the main drawbacks of these data driven methods is their inability to efficiently exploit the core structures and properties of the problem. More specifically, existing data driven methods primarily focus on the objectives to be optimised but often neglect various complex inter‐dependencies among the decision variables (in the form of constraints) and their collective influence on the objective. In this research, the students shall investigate integrating linear/integer programming methods with the latest deep learning methods, including but not limited to reinforcement learning and graph neural network based learning.
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Project title	Tackling the pandemic of antibiotic-resistant infections: An artificial intelligence approach to new druggable therapeutic targets and drug discovery
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Bioinformatics
Supervisory Team	Tania Dottorini
Short introduction of research project	The use of antibiotics to control bacterial infections is perhaps the most important achievement of modern medicine. However, we have failed to keep pace with microbes becoming increasingly resistant to available treatments. Antibiotic-resistant infections are already another global pandemic claiming almost 5 million deaths per year globally. The increasing isolation of strains resistant to "last resort" antimicrobials has significantly narrowed, or in some settings completely removed, the therapeutic options. This is particularly alarming in low and middle-income countries. Unfortunately, new classes of drugs are not being invented and resistance continues to spread inexorably. A better understanding of the means used by microbes to resist antibiotics may result in the discovery of hitherto unknown targets suitable to develop new drugs against. In this research, we will use artificial intelligence, bioinformatics and microbiology to identify new potential druggable targets that when blocked may render the microbe susceptible to antibiotics. Next, and utilizing other learners, we will identify drugs that can block these targets. Our analysis will also target another important aspect linked to antibiotic-resistant infections that is transmission, again using a combination of expertise we will use our and publicly available data to study drivers and transmission of resistant pathogens in different anthropogenic environments including (communities, hospitals, livestocks, etc.,)
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Project title	To explore the genetic mechanisms of multiple pain phenotypes based on the UK Biobank cohort
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Bioinformatics
Supervisory Team	Weihua Meng Mainul Haque
Short introduction of research project	There are many site-specific pain phenotypes in the human body such as back pain, hip pain, knee pain, etc. These pain phenotypes could be considered as common complex traits like diabetes. However, we have limited knowledge about the genetic mechanisms of these pain phenotypes despite some studies have suggested that genetic components play a role in the disease mechanisms. The UK Biobank has collected the genetic information and pain-related information of its participants which make this genetic research possible. We aim to identify the genetic variants that contribute to multiple pain phenotypes through a genome-wide association study (GWAS) approach using the UK Biobank datasets. We will also investigate the genetic correlations among these pain phenotypes. Year 1: the student will receive training in background reading and get familiar with GWAS software. Year 2: the study will perform multiple GWAS to explore potential genetic variants for pain phenotypes. Years 3: the student will submit manuscripts to journals and publish them. Meanwhile prepare his/her dissertation.
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Project title	Wearable Optical Biosensor
Programme	PhD Electrical and Electronic Engineering
Department or School	Department of Electrical and Electronic Engineering
Research area	Life Science and Healthcare
Supervisory Team	Dr. Jing Wang, Dr. Richard Smith, Dr. Sen Yang
Short introduction of research project	For patients with severe diseases, e.g. elderly people or new-born babies, the real-time monitoring of multiple physiological indices during MRI scanning is essential. Due to the strong electromagnetic field in MRI Scanner room, the traditional electronic sensors for monitoring health status will be damaged. This project proposes an MRI compatible wearable sensor based on Fiber Bragg Grating (FBG) technology with the advantages of immunity to EM fields, high sensitivity, light-weight, high flexibility, high stability, low cost and small size. This wearable sensor is able to monitor the following parameters in real time: 1. Human physiological indices: body temperature, heart rate, blood oxygen level, breathing, volume of perspiration; 2. Environmental parameters, i.e. room temperature, humidity and audio level. Besides real-time monitoring, machine learning will be adopted in data analysis, in order to analyse the patient's emotion and to identify any dangerous circumstances, e.g. sudden apnoea, abnormal heart rate. For example, the audio signal will be separated into environmental audio and human audio, and based on the signal of human audio, breathing, heart rate, and body temperature, dangerous circumstances can be diagnosed and a warning message will be sent to the doctors immediately. The proposed system, with only minor modification to the system setup, can also be used as daily or long-term physiological monitoring within normal environment where there is a need. The objectives of this proposed research in Phase I are to: 1. Design and setup a sensing system for the real-time detection of human physiological indices (body temperature, heart rate, blood oxygen level, breathing, volume of perspiration) and environmental parameters (room temperature, humidity and audio level), which is mainly designed for simultaneous monitoring of patients during MRI scanning. 2. Develop the diagnosing and warning system using signal processing techniques and machine learning algorithm. 3. Investigate the relationship between physiological indices (especially PWV) with hypertension and angiocardiopathy.
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Project title	AI Enabled Drug Discovery
Programme	PhD Chemical Engineering
Department or School	Department of Chemical and Environmental Engineering
Research area	Life Science and Healthcare
Supervisory Team	Dr. Bencan Tang Dr. Jianfeng Ren Professor Jonathan Hirst
Short introduction of research project	The development of anticancer drugs involves drug-like molecule design and synthesis, lead identification and optimization, as well as later development in clinical trials, and then finally marketing. Computer aided drug development can greatly reduce the research and development (R & D) cycle and R &D costs. Within this, artificial intelligence is currently actively adopted for drug screening, design and synthesis. As a powerful data analysis and data mining tool, machine learning, as an important branch of artificial intelligence, is expected to play an important role in virtual screening. This project aims to set up an artificial intelligence based anti-cancer drug discovery platform with the ability to virtually screen potential anti-cancer candidates. The screening of inhibitors for high-risk tumor related targets such as BRCA, EGFR, LSD1, PARP, DNMT1 will be carried out as case studies for this platform. Meanwhile the obtained potential inhibitors for these targets will be synthesized for biological tests and further development. We are seeking TWO PhD students in this project. **Candidate 1** is expected to carry out synthesis who should have strong experience in medicinal chemistry and organic synthesis. **Candidate 2** is expected to have strong experience in applying machine learning in drug screening, who ideally should have experience in computer programing. You are welcomed to contact us (via email bencan.tang@nottingham.edu.cn) to discuss these opportunities further.
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