THE UNIVERSITY OF WESTERN AUSTRALIA

ENGINEERING AND MATHEMATICAL SCIENCES

Master of Professional Engineering & Bachelor of Engineering

Engineering Research Project Descriptions

GENG5511/GENG5512

Semester 1, 2020

To find a project description, search (Ctrl + F) using the Supervisors surname. The project title and description are listed below each Academic's name. Please ensure that the project is applicable to your discipline.

Akhtar, Naveed, Dr.

Hassan, Ghulam Mubashar, Dr.

Analyzing adversarial examples for Deep Learning

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Programming skills in Python

It is widely claimed that adversarial examples are able to fool state-of-the-art deep learning techniques with slight modifications to the inputs that remain imperceptible to Humans. For example, we can make an image of Ostrich appear a Dog to a deep model. There are many "attack" algorithms that can achieve this feat. However, many facts related to the mutual relationships of these algorithms and their adversarial examples remain unexplored. This project is aimed to highlight the commonalities and disparities between different attack algorithms and their adversarial examples. It will study the existing attack methods, generate adversarial examples using those techniques and rigorously analyse them to evaluate the nature of threat that adversarial examples pose to deep learning.

Al Ghafri, Saif, Dr

May, Eric, Prof

Improved Viscosity Modelling for Natural Gas Mixtures

Disciplines: Chemical, Mechanical

Prerequisite skills: Data analysis and literature survey

Production and optimization of natural gas process is designed using predictions of the mixture's thermodynamic and transport properties over wide range of pressure, temperature and composition conditions. However, the extent to which engineering margins are used in such designs is mainly influenced by the accuracy of the property predictions (such as viscosity) used in the process simulation. The accuracy of the models used for predicting the fluid properties are in turn dependent on the extent and uncertainty of experimental data used to develop and validate the model. This project aims to explore and improve the prediction of viscosity models for natural gas mixtures. In particular, the focus will be on optimizing the prediction of friction theory (FT) approach against comprehensive viscosity data from the literature.

Al Ghafri, Saif, Dr

May, Eric, Prof

Experimental Analysis and Simulation of LNG Boil-off-Gas

Disciplines: Chemical, Mechanical

Natural Gas (NG) is transform into Liquefied Natural Gas (LNG) to be transported in an economic way, during which Boil-Off gas (BOG) can occur. This an important phenomenon that affects the gas industry, specifically during the storage and transportation of LNG. Furthermore, it can lead into the formation of stratified layers where a sudden mixing of existing stratified layers within a liquid phase occurs (Rollover). Limited data is available in literature and models fail to accurately predict this incident. The development of reliable and detail measurements will provide significant benefits in both transportation and storage of this energy source.

This research mimicked the conditions of an LNG vessel by building and designing a laboratory BOG apparatus that will allow the study of the effect of heat flux, volume, Boil-Off gas rate and composition on the BOG. The apparatus is already built and installed where variety of LNG mixtures will be studied during transient and steady state conditions at a temperature of -162 °C and around 1 atm. These measurements will help to design an accurate model to predict this phenomenon and it will be compared to other models available in literature.

Al Ghafri, Saif, Dr

May, Eric, Prof; Stanwix, Paul, Dr

Future of Hydrogen Economy in Western Australia: Requirements of Further Technical Research

Disciplines: Chemical, Mechanical

Prerequisite skills: Data analysis, process design and process simulation

The emerging Hydrogen Economy has been identified as a strategic research and industrial opportunity for Western Australia. However, building a green Hydrogen Economy presents a number of scientific and technological challenges across the entire hydrogen value chain (production, transportation, storage and utilization).This project will involve data gathering and analysis on the specific requirements for thermophysical property measurements and process simulation and design of pipeline transportation, storage, and processing of hydrogen, based on improved thermodynamic molecular models

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Aman, Zach, Prof

May, Eric, Prof; Metaxas, Peter, Dr

Flow Assurance and Natural Gas Hydrates

Disciplines: Chemical, Mechanical

Natural gas hydrates are ice-like solids that form and can often suddenly stop the flow during oil and gas production. The cost of their prevention during design and production is high and the removal of hydrate plugs is expensive and dangerous. Today hydrates are still a major flow assurance concern especially as production moves to deeper water, and many of Australia's major new gas field developments are considering innovative approaches to this long-standing problem. These projects aim to provide the knowledge needed for a risk-based approach to hydrate management by establishing quantitative model to assess plugging potential, optimize inhibitor doses, and develop methods to detect hydrate formation and location. The outcomes will help reduce chemical use by the industry, provide better methods to locate plugs and provide safer methods for their remediation, ultimately allowing for the reliable and economic development of marginal oil and gas fields. Students working on these projects will measure and/or model hydrate formation, agglomeration and dissociation processes. Naturally-occurring gas hydrates also represent a tremendous energy reserve: in 2013, first production was reported from a naturally occurring hydrate reserve located offshore the coast of Japan. Projects will also be available in which various properties of these natural hydrates are quantified, such that more informed decisions regards the exploitation of natural hydrates can be made.

An Hongwei, Dr

Local scour around Cryogenic subsea Pipelines

Disciplines: Civil, Mechanical
Prerequisite skills:

The transportation of liquefied natural gas (LNG) requires a pipeline system to transfer LNG between floating tankers and the onshore plant. Cryogenic pipelines have to cope with inner low temperatures, maintain ambient temperature outside and provide sufficient strength so as not to fail. This novel subsea pipeline system will remove the trestle, terminal and long breakwater wall and shift the terminal further off the coast and into deeper waters (20-50 m). The corresponding cost saving may be as high as 60%. The challenge is now for civil engineers to develop design tools for this new pipeline, which is heavier and stiffer compared to conventional pipelines.

The project will investigate the local scour process around Cryogenic pipeline in relatively shall water condition through physical experiments. The research outcome will be able to help with the stability design of the pipeline. This project would be suitable for students interested in practical applications of offshore engineering, particularly subsea pipeline developments. The research is a part of the ARC linkage project (LP170101080).

An Hongwei, Dr

Visualizing Flow Around a Group of Cylinders

Disciplines: Civil, Environmental, Mechanical
Prerequisite skills:

A group of cylinders is often seen in offshore strictures. The flow field around the cylinder group involves a wide range of interesting flow features. A series of numerical simulations will be conducted using open source software (OpenFOAM). The flow field and hydrodynamic forces on the cylinders will be examined. The research outcome can be potentially applied in different engineering areas.

Through this project, students will have opportunity to learn the widely used free software (OpenFOAM) and will have access to the most powerful supercomputer in Australia, Magnus from Pawsey Supercomputing center.

An Hongwei, Dr

Visualizing Flow Around a cube at high Reynolds number

Disciplines: Civil, Environmental, Mechanical
Prerequisite skills:
Flow around a cube will be simulated numerically at high Reynolds number. The flow field around a cube involves a wide range of interesting flow features, such as flow separation, re-attachment, vortex shedding and transition to turbulence etc. A series of numerical simulations will be conducted using open source software (OpenFOAM). The research outcome can be potentially applied in different engineering areas.

Through this project, students will have opportunity to learn the widely used free software (OpenFOAM) and will have access to the most powerful supercomputer in Australia, Magnus from Pawsey Supercomputing center.

Arami Niya, Arash, Dr

May, Eric, Prof

Alternative refrigerants

Disciplines: Chemical, Mechanical

A new generation of refrigerants known as hydrofluoroolefins (HFOs) have much lower global warming potential (GWP) compared to traditional refrigerants. However, due to their lower coefficients of performance (COP), blending HFOs with others refrigerants such as hydrofluorocarbons (HFCs) is recommended for many industrial cycles. To design and simulate these applications, industry needs property data for these mixtures to be measured at relevant conditions of pressure, temperature and composition so that equations of state and transport property models can be anchored to them.

Arami Niya, Arash, Dr

May, Eric, Prof

Advanced Separation Technologies for Helium Recovery from Natural Gas

Disciplines: Chemical

Helium (He) market experiences a rapid increase in price due to the growing rate of helium demands, uncertain resources and low production of He. The only practical source of He is from certain natural gas fields that He concentrations is only 0.3 % in the best case. Helium is conventionally separated from the natural gas by cryogenic distillation which is expensive for both capital costs and energy consumption. Thus, finding alternative technologies such as adsorption-based processes would be critical to reducing the overall cost of He production and as a result, having the potential to affects the uneven He market. The objective of this project is to develop novel adsorbents with appropriate helium selectivity and design of advanced adsorption-based cyclic process configurations that can replace the current cryogenic processes for the enrichment of dilute He from natural gas.

Arami Niya, Arash, Dr

May, Eric, Prof

Novel adsorbents for gas separation for natural gas processing

Disciplines: Chemical

Application of adsorption based gas separation processes in natural gas purification and carbon capture can be a promising alternative for the current conventional energy-intensive thermal separation processes. At the moment, removal of acid gas from a sour gas feed using methyl diethanolamine (MDEA) is one of the primarily absorption processes in LNG production plants, which requires a large amount of energy for regeneration of the solvent. Due to the low loading capacity of physical solvents, they are not competitive to the chemical solvents such as amines. In this project, we will explore the application of an intriguing class of materials (Metal Organic Frameworks), and also their derivatives in important LNG related gas separation such as N2 capture from natural gas and also carbon capture and storage (CCS).

Aslani, Farhad, Dr

Superelastic SMA reinforced concrete beams

Disciplines: Civil, Mechanical
Prerequisite skills:
The use of superelastic shape memory alloys (SMAs) as a reinforcing material in concrete structures is gradually gaining interest among researchers. Because of SMAs' different mechanical properties compared to regular steel, use of SMA as reinforcement in concrete may change responses of structures under seismic and repeating loads. The objective of this

study is to investigate the structural performance of superelastic SMA reinforced concrete beams under repeating loads and to develop a preliminary understanding of these beams.

Aslani, Farhad, Dr

3D printing concrete structures

Disciplines: Chemical, Civil, Mechanical, Mining
Prerequisite skills:
When 3D printing comes into the field of real life building, the main challenge is the design and preparation of concrete materials that are compatible with the 3D printer. A few of cementitious material for 3D printing have been explored for construction applications. In general, the design and preparation of concrete for 3D printing mainly relies on optimizing the compatibility and coordination of concrete with the printer. The aim of this project is to printable properties and mechanical behaviours of cementitious materials using extrusion-based 3D printing technology.

Aslani, Farhad, Dr

Engineered cementitious composites for modern structures

Disciplines: Civil, Mechanical, Mining
Prerequisite skills:
Engineered cementitious composites (ECC) are a special class of fiber-reinforced cement-based composite materials (FRCC), typically reinforced with 2% short fibers to achieve strain-hardening and multiple cracking in tension. ECC exhibits tensile strain-hardening behavior with strain capacity in the range of 3–7 %, more than 300 times that of normal concrete. This strain capacity is obtained through the formation of numerous closely spaced micro-cracks under load, allowing the material to deform similar to ductile metals. In recent years, ECC has been successfully utilized in many interesting field applications, most of which demand limited crack widths, reduced cross sections, or a high tensile strain capacity. The aim of this project is to study some unique properties of fresh and hardened ECC to provide better understanding of its behavior under different loading regimes.

Bekki, Kenji, Dr

Automated finding of the best galaxy model through a novel combination of deep learning and particle swamp optimization

Disciplines: Electrical & Electronic, Mechanical

Prerequisite skills: Python programming and basic knowledge about machine learning (deep learning, ideally).

It is generally a time-consuming task for astronomers to find the best model for a galaxy, because a large parameter space needs to be explored through computer simulations. In this project, students will dramatically reduce the amount of time required for the best model search through a novel combination of (i) deep learning for data analysis and (ii) particle swamp optimization for parameter search. Convolutional neural networks (CNNs) will be used to classify galaxies and a large number of images from computer simulations will be used to train the CNNs. A long-standing key problem related to galaxy formation will be addressed through the novel combination for data analysis.

Bekki, Kenji, Dr

Deep learning for classifying the synthesized images of galaxies from computer simulations

Disciplines: Biomedical, Chemical, Software

Prerequisite skills: Programming skills of Python and Keras/Tensorflow (AI libraries), some basic knowledge about deep learning

Learning is classifying. Therefore, classifying galaxies can lead us to learn important aspects of galaxy formation and evolution. In this project, students will try to develop a new convolution neural network (CNN) to classify the synthesized images of galaxies produced by high-resolution computer simulations of galaxies. First, students in this project will use a million of synthesized galaxy images to train the CNN for an automated classification of galaxies. Then they will classify the observed images of galaxies from telescopes using the trained CNN in an automatic way. This novel galaxy classification scheme will be able to be used for real scientific research to discover something new (e.g., new discovery of hidden spiral arm structures, massive black holes, and dark matter etc). Students who are interested in this project are encouraged to discuss this project with Kenji Bekki (kanji.bekki@uwa.edu.au) before they take this project.

Bekki, Kenji, Dr

Can artificial intelligence discover the Newton's law of gravity?

Disciplines: Software

Prerequisite skills: Programming skills of Python and Keras/Tensorflow (AI libraries), some basic knowledge about deep learning and high school level physics.

Deep learning is the key element of AI (artificial intelligence) technologies that are currently revolutionizing our industries. In this project, students will discuss whether or not deep learning can be used to discover the Newton's law of gravity based on a large amount of data from computer simulations. First, students will train a convolutional neural network (CNN) using a large amount of data for positions and velocities of planets around the Sun in order to find the orbital eccentricity and the angular momentum of the planets (both of which are ``invariants" in their orbits). Then, students will try to develop a CNN by which the Kepler's third law and the Newton's law of gravity can be inferred from the data in an automatic way. Thus, the development of AIbased ``discovery engine" is a main purpose of this project. The method adopted in this project is quite different from those in previous works (e.g., P. Langley, 1981, Cognitive Science, 5, 31). Since this project is a bit ambitious, students are encouraged to discuss the details of the project before they take the project (through e-mails or face-to-face meeting).

Boussaid, Farid Professor

Electronic eye

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Programming and mathematics

Despite significant advances, there is still today a huge gap between exiting cameras and what can be achieved by the human eye. The retina can adapt to almost any lighting condition and will consumes relatively little power. Engineers have turned their attention to biologically inspired camera architectures that promise to deliver high performance at an ultra-low power usage. In this project, you will work with such a bio-inspired camera and develop algorithms to emulate brain visual processing.

Boussaid, Farid Professor
Co-supervisors:

Design of a computer controlled gas sensor testing system

Disciplines: Electrical & Electronic

Prerequisite skills: Electronics

In this project, you will design a computer controlled gas sensor testing system enabling automatic readout and processing of data, accurate control of temperature, gas flow, and gas concentration within the testing chamber.

Boussaid, Farid Professor
Co-supervisors:

Brain Machine Interface

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Programming and mathematics

In this project, you will investigate brain machine interface technologies allowing people with motor or sensory impairments to control external hardware such as computer or robotic arms.

Bransby, Fraser, Prof
Co-supervisors: Fugro Perth

Testing to reveal seabed stiffness for risers

Disciplines: Civil Engineering

Risers are long 'pipeline' sections which take oil or gas from the seabed, through the water column, to a floating structure (or vice versa). These risers oscillate due to water and vessel movements. If incorrectly designed, risers can experience fatigue failure near where the riser touches down on the seabed due to the mechanical constraint at the seabed which bends the pipeline. In general, a high seabed stiffness generates more fatigue loading and a shorter design life - so it is important to be able to predict this accurately during riser design. Selecting this value is difficult because it depends on the amplitude of the oscillations, their duration and frequency, as well as seabed and riser properties.

The project will involve conducting a series of laboratory experiments to quantify how the amplitude of the cycling and its duration affect the emerging stiffness of the seabed. A box of clay will be prepared with known properties to represent the seabed. Tests will then be carried out by moving pipeline sections up and down many times in the 'seabed' with varying amplitudes, whilst measuring the load-displacement response to see how the seabed stiffness varies between and within each test. It is expected that two different 'seabeds' will be prepared - one where the soil is normally consolidated (left to settle under its own weight in a box), and another where the soil is overconsolidated through some initial preconsolidation to bracket the range of likely conditions offshore. The tests are likely to produce large volumes of data, which will be analysed to allow comparison of the results to current design methods, and potentially to help improve design approaches.

This project is supported by Fugro who provide specialist geotechnical advice to numerous offshore oil and gas developments both in Australia and worldwide. Fugro suggested this topic based on recent work where similar (but more limited) tests were conducted on a vessel offshore in a sample taken from the seabed in order to provide advice for a deep water project. Consequently, this project provides the opportunity to work collaboratively with the Fugro geotechnical consulting team in the City (many of whom graduated from UWA) on a topic of relevance to the industry and present the findings to them at the end of the project.

Bransby, Fraser, Prof
Co-supervisors: An, Hongwei, A/Prof, Fugro Perth

Predicting jack-up instability due to local scour

Disciplines: Civil Engineering

Jack-ups platforms are used as temporary facilities to support construction activity offshore as they can be towed to site, 'jacked-up' onto the seabed and then removed after use. As such, jack-ups are used in a wide range of offshore projects, with a recently large expansion due to the growth of the offshore wind market.

In shallow water conditions there may be dense sands and so the spud-can (of perhaps 12 m diameter) which acts as the foundations at the end of each of the three of four jack-up legs will not penetrate far into the seabed (perhaps a few metres at most). This means that the spud-can foundation could be exposed to the effects of scour while installed on the seabed. Removal (i.e. scour) of soil around the spudcan because of increased water velocities around the jack-up could have the effect of undermining the foundation leading to the foundation penetrating into the seabed during its design life during different storm, tide or cyclonic events. This may be allowed for by jacking down the legs to compensate if it occurs slowly, but has the risk of either being too fast in a cyclone to compensate for (generating overall instability if different legs move down different amounts) or reducing the foundation capacity at key instants of loading (also leading potentially to overall jack-up instability).

The project will involve conducting a series of experiments in the small O-tube apparatus to investigate this phenomenon and therefore improve design recommendations. A model jack-up leg with a spud-can at the end will be installed into a model sand 'seabed' and then different current (and/or wave) conditions will be simulated by controlling the velocity of water flow past the jack-up leg in the O-tube. The tests will allow examination of how the penetration of the leg increases and how the soil is scoured around the spud-can as the spud-can penetration changes for different hydrodynamic conditions.

This project is supported by Fugro who provide geotechnical advice to multiple projects both in Australia and worldwide. Fugro has identified this topic as worth researching given that advice about this phenomena to jack-up operators is not supported by experimental evidence. Consequently, the project provides the opportunity to work collaboratively with the Fugro consulting team in the City (many of whom graduated from UWA) on a topic of relevance to the industry and present the findings to them at the end of the project.

Bransby, Fraser, Prof
Co-supervisors: Fugro Perth

Lateral seabed resistance for self-buried pipelines in carbonate sands

Disciplines: Civil Engineering

Pipelines are used to transport gas and liquids along the seabed from the source to the processing plant. They are therefore a critical part of the infrastructure in any offshore oil and gas project and their reliability must be ensured. One critical input to pipeline design is how the pipeline will interact with the seabed: the interaction with the seabed controls how the pipeline responds when it heats up and/or is pressurised and determines whether the pipeline is stable on the seabed when loaded by cyclones. Pipeline geotechnics is therefore a critical part of the design chain and recent Australian megaprojects (e.g. Gorgon, Pluto, Wheatstone, Ichthys etc.) have all involved significant numbers of pipelines where geotechnical design advice was required. Execution of these projects has led to large advances in design practice, but also revealed gaps in our understanding, particularly for the carbonate soil conditions encountered on the North-West Shelf of Australia.

In particular, observations of pipelines following their installation on the seabed has revealed that their burial state often changes with time, sometimes even before the pipeline is switched on, because of sediment mobility. Consequently, increasing amount of design work for recent and upcoming projects in Australia requires prediction of (a) the amount of burial change that will occur with time and (b) how the seabed resistance to pipeline movement (e.g. when loaded by a cyclone or when the pipeline heats up) will change due to these changes in burial state. This project will investigate the seabed resistance for different burial states by performing a series of experiments in the laboratory. The collected data will then be used to support and validate the design method that is currently adopted in practice.

Tests will be performed in the laboratory by creating a (carbonate) sand sample (representing the seabed), placing a pipeline on the sand surface (to mimic how the pipeline is installed onto the seabed), changing the burial conditions of the pipeline by placing soil around the pipeline in selected geometries (to mimic how sediment mobility will change the burial conditions with time) and then pulling/pushing the pipeline horizontally to measure the available seabed resistance. Repeating the test for several different conditions will allow investigation of the phenomenon and form a basis for design. Some soil laboratory elementary tests may be performed to provide data on the properties of the tested sand for the analysis of the test data. Potential extension work could include either performing computer-based calculations (using a commercial package) to investigate how the calculated resistance compares to the measured value, or extending the experimental work using photographic image analysis (using existing in-house software) to understand how the pipeline interacts with the seabed as the pipeline moves.

This project is supported by Fugro who provide specialist geotechnical advice to multiple pipeline (and other offshore infrastructure) projects both in Australia and worldwide. The project provides the opportunity to work collaboratively with the Fugro consulting team in the City (many of whom graduated from UWA) on a topic of relevance to the industry and present the findings to them at the end of the project.

Bräunl, Thomas, Professor

Driverless Cars

Disciplines: Electrical & Electronic, Mechanical Eng., Software Eng.

Prerequisite skills: Completion of ELEC4403 Digital and Embedded Sys. or CITS2200 Data Structures. Good programming skills in C and Python or C++ are essential.

We are currently operating two autonomous vehicles, a donated BMW X5 and a student-built Formula SAE-Electric vehicle. Both vehicles already have full drive-by-wire technology implemented and are equipped with several sensor systems, including GPS, camera, Ibeo Lux Lidar, Xsens IMU (inertial measurement unit) and wheel encoders. The project operates as a student led team with support and mentorship from faculty, PhD students and industry professionals and has a strong history of academic publication.

We are using the latest automotive control hardware with an Nvidia Jetson AGX Xavier system which provides real-time sensor processing and accelerated deep learning capabilities and currently utilise a Robot Operating System (ROS) based software stack with C++ and Python nodes. Our project also includes high-reliability embedded systems, using Texas Instruments Hercules Dual-Lockstep ARM CPUs. The use of the Formula SAE car allows hands on testing on campus in addition to the use of our lab-based hardware-in-the-loop test system for software development.

Goals:

- Autonomous navigation on UWA-internal roads and on external race track
- Sensor fusion of GPS, 3x Lidar, inertial measurement system, odometry, vision.
- Map building and SLAM
- Path planning, optimisation and collision avoidance
- Implementation of a vision sub-system for road and vehicle detection using OpenCV http://opencv.org
- Implementation of image detection, classification and end-to-end control using deep-learning systems such as Caffe and Tensorflow for real-time control http://caffe.berkeleyvision.org

Software Engineering Opportunities:

- Design of ROS node architecture and data flows for multi-application autonomous driving.
- Implementation of standards-compliant C based embedded controller firmware for safety system and drive-by-wire controller on an ARM platform.
- Implementation of reliable TCP/IP based control network to interface ROS node with safety and drive-by-wire system.
- Implementation of custom ROS nodes in Python or C++ for vehicle control and system monitoring.
- Implementation of efficient, high-speed LIDAR data processing algorithms.
- Implementation deep-learning algorithms using TensorFlow (etc.) and optimising for inference on NVIDIA hardware.
- Optimisation of video capture and DNN inference pipeline using C++ within ROS.
- Implementation of user-interface and API for both remote control station and in-car dashboard (either Qt or web-based stack).

Further Details:

http://revproject.com/vehicles/bmw.php

http://revproject.com/vehicles/sae2010.php

https://www.ros.org

Bräunl, Thomas, Professor

Autonomous Driving Robots and Virtual Reality

Disciplines: Electrical & Electronic, Software Eng., Mechanical Eng.

Prerequisite skills: Completion of ELEC4403 Digital and Embedded Sys. or CITS2200 Data Structures, Programming experience in C, C++ or Python, Desirable: Taking unit GENG5508 Robotics concurrently or before.

We are using advanced driving robots similar using Raspberry Pi controllers for implementing a fully autonomous traffic scenario, inspired by the **Carolo Cup**. https://wiki.ifr.ing.tu-bs.de/carolocup/

Goals:

- Lane detection, obstacle avoidance and autonomous driving on track
- End-to-end learning of driving tasks
- Visual Navigation
- Robot Swarms (in reality and in VR)
- SLAM (Simultaneous Localization and Mapping)

Further Details:

http://robotics.ee.uwa.edu.au/eyebot7/EyeBot7-UserGuide.pdf

http://robotics.ee.uwa.edu.au/eyesim/

https://www.tensorflow.org

Bräunl, Thomas, Professor

Co-supervisors:

Hydrofoil Electric Jetskis

Disciplines: Electrical & Electronic, Software Eng., Mechanical Eng.

Prerequisite skills:

A new hydrofoil electric jetski has been built, but riding it requires some skill to keep it balanced. The task for this project is to implement an automated balancing system that reads sensor data from an inertial measurement unit (IMU) to control the underwater ailerons of the watercraft. This should allow a completely balanced ride even for novice users.

Goals:

- Development, installation and testing of stabilisation system
- GPS Tracking

Further Details:

http://revproject.com/vehicles/hydrofoil.php

Cense, Barry, Associate Professor

Co-supervisors: Hadi Afsharan

Bilirubin sensor

Disciplines: Electrical & Electronic, Biomedical

Prerequisite skills: Matlab

Bilirubin is a waste material that can build up in the human body. In healthy humans, the concentration of bilirubin is about 3 microMol/l. At these relatively low levels, commercial bilirubin sensors - which were developed to detect much higher concentrations in babies - cannot accurately detect its concentration. We are therefore looking for a different method that provides more accuracy. The goals of the project is to develop a non-invasive measurement method to quantify bilirubin in healthy human subjects.

Cense, Barry, Associate Professor

DC motor setup for catheter

Disciplines: Electrical & Electronic, Biomedical

Prerequisite skills: Matlab, Arduino, C++

At OBEL, we use catheters to image the insides of airways, the esophagus and blood vessels. These catheters spin and are pulled through a cavity, thereby providing an image in a corkscrew fashion. In this project, you will change the existing design, which is based on a stepper motor to rotate the catheter, with a design that incorporates a DC motor + encoder. These motors can be run such that the data acquisition and spinning are in sync.

Cense, Barry, Associate Professor

Co-supervisors: Qiang Wang

Phantoms for optical coherence tomography and speckle imaging

Disciplines: Biomedical

Prerequisite skills: Matlab

Optical coherence tomography (OCT) is a non-invasive, high resolution (1-20μm), three dimensional imaging technology which delivers cross-sectional tomographic images of the biological tissue. OCT angiography (OCTA) is an extension of OCT, which offers label-free imaging of small blood vessels with diameter of tens to hundreds micrometre including arterioles, capillaries and venules, at a several millimetre in wide and 1-2 millimetre in depth of field of view. Currently, there is a lack of comprehensive comparison of different OCTA methods to characterise their applicability for scientific and clinical settings. In a complicated in vivo biological tissue experiment, the quality of the OCTA image may be affected by a lot of uncertain factors, such as breathing vibration, blood flow pulsatile velocity, shadow of body hair or red blood cells, and so on. In order to research and understand these issues, a controlled flow phantom is needed to mimic the blood vessel environment to achieve controlled experimental results. In our lab, we use titanium dioxide powder and silicone to mimic a background matrix, a glass capillary to mimic the vessel wall, and a polystyrene microsphere solution to mimic the blood. Titanium dioxide powder tends to clump together. The glass capillary is a few hundreds of micrometres wide and breaks easily. A flow phantom is therefore hard to make and clogs easily. This project is aimed to optimize the phantom design, and to test the different phantoms with OCTA.

Chow, Shiaohuey, Dr.

Field Investigation of the Novel Dynamic Installed Fish Anchor in The Swan River

Disciplines: Civil
Prerequisite skills: Basic knowledge of geotechnical engineering principles.

Would you like to participate in the **Woodside FutureLab RiverLab** (www.bit.ly/riverlab) working on innovative engineering solution? This RiverLab project aims to unlock the potential of a novel dynamically installed anchor. Dynamically installed anchors (DIAs) are the most recent type of anchoring solution providing a cost-effective alternative for mooring floating facilities in deep water clayey sediments. They are also being increasingly considered in shallow waters for temporary mooring of floating facilities and for mooring floating wind turbines. DIAs are installed by free-fall dropping through the water column and then penetrating into the seabed. This necessitates no external energy source and hence the installation method can be applied in any water depth.

A novel dynamically installed anchor, known as the fish anchor has been developed and patented at UWA. This project aim to assess the performance of the anchor and validate its interpretation method by conducting field trials in the Swan River. This project will require a team of two students, one investigating the anchor installation and another investigating the capacity of the fish anchor. Interested students are encouraged to contact Dr Shiaohuey Chow (shiaohuey.chow@uwa.edu.au) or Dr Youngho Kim (youngho.kim@uwa.edu.au) for more information.

Coward, David, A/Prof

Space debris and satellite material degradation (Industry collaboration)

Disciplines: Chemical, Software

Prerequisite skills:

One important aspect for tracking space debris is understanding how defunct satellites degrade over time to produce more space debris. The project will use multi-band imaging of a number of geosynchronous satellites to determine changes in the surface properties of various types of satellites by surface reflectance that vary across optical wavelength.

David Reid, Dr

Unique modelling of the Mt Polley tailings failure in three dimensions

Disciplines: Civil
Prerequisite skills: Completion of ENSC 3009 Geomechanics

The Mount Polley tailings dam failed in 2014, with a failure investigation published soon after in 2015. This indicated failure was through a clay later below the embankment. Although the investigators were able to produce a reasonable match to the failure using a two dimensional model, their three dimension model was unable to recreate the failure. This is problematic, as for a failure of known dimensions such as Mount Polley, three dimensional analysis should give the most accurate result.

This project will involve using a cutting edge three dimensional slope stability modelling program to reassess the Mt Polley failure, looking at factors that were not considered by the original investigator. The cutting-edge three dimensional software package Slide 3 will be used for this work.

David Reid, Dr

Studying the collapse of tailings dams with a lab-scale direct simple shear device

Disciplines: Civil
Prerequisite skills: Completion of ENSC 3009 Geomechanics

A number of tailings dams have collapsed suddenly in the past 10 years. These failures have major implications for the mining industry, and research to improve their safety is currently being carried out around the world. One form of laboratory testing to assess the stability of a tailings dam is referred to as "constant shear drained" (CSD) testing, which simulates how a relatively slow increase in the water level within a tailings dam can lead to sudden failure.

This project will involve carrying out a series of laboratory tests using UWA's purpose-build CSD device on a number of tailings from around Australia. This data will help quantify the risk of these tailings dams, and provide additional information on the failure behaviour of different tailings types.

De Juan Pardo, Elena, Dr

Keating, Adrian, Prof

Design and manufacture of an enhanced melt electrowriting 3D printer

Disciplines: Mechanical, Software

Prerequisite skills: 3D printing, CAD, Programming (Python)

The MEW printer will include a newly design head suited to print at high temperatures, to allow for broader range of thermoplastics to be implemented. It will also achieve variable control of applied voltage and pressure to increase reliable large build prints with tuneable filament sizes.

Durham, Richard, Prof

Windrow Design

Disciplines: Civil, Mechanical, Mining
Prerequisite skills:
All open pit mines uses piles of rock (windrows) along roads/ramps to prevent vehicles falling over the edge! The design of these is to be investigated.

A large mining company has asked us to:

(1) do a review of what is common practice

(2) outline the theory behind that

(3) produce some design guidelines for their construction.

Obviously (3) is the largest item, and might involve modelling a large mass (truck) hitting some loose particles (the windrow) at various angles and speeds. This modelling could use finite elements, or particles or both. There is a 500 page research study which can serve as a starting point.

Durham, Richard, Prof

Industry topic (usually based on your vacation work)

Disciplines: Mining
Prerequisite skills:
During your vacation work, you should ask your employer if they have any topic(s) suitable for your thesis. Ask them at the beginning, and then again towards the end. You need to write

up the topic on <1 page, and send it to me. There might be a little negotiation whilst I ensure the topic is suitable (basically not too small, not too big, and involves some research type analysis), but once we've agreed on the scope and objectives it's all fine.

Durham, Richard, Prof

VR Applications in Mining Engineering

Disciplines: Software
Prerequisite skills:
A previous thesis by a student loaded a mine design into a VR environment, and showed how that would be useful to engineers. More work is required to use "off the shelf" packages (and the latest cordless headset, or Hololens) to take a design into VR, and apply textures, queries etc.

Durham, Richard, Prof

Improving the Nicholas/UBC UG Mining method tool

Disciplines: Mining
Prerequisite skills:
The Nicholas/UBC spreadsheet for helping select an UG stoping method has many flaws, making it of very limited real use. This project seeks to replace it with more modern approaches, more modern methods, and fuzzy logic

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Durham, Richard, Prof

Minimisation of dilution by drilling and blasting design parameters

Disciplines: Mining
Prerequisite skills:
Dilution is one of the major issues in underground mining. Recent studies proved that mine dilution is not only related with the quality of the rock mass around the stope but also related with the drilling and blasting design parameters. The purpose of this study is to analyse the possibility of minimising mine dilution by adjusting drilling and blasting design parameters. For this purpose a database constructed from an underground mine in WA will be used. The first step will be the construction of predictive model/s connecting mine dilution to design parameters by using different modelling approaches such as conventional regression and evolutionary algorithms. In the second step an optimisation algorithm will be implemented by using the constructed predictive model/s as an objective function/s.

Durham, Richard, Prof

Improving Taylor's Rule

Disciplines: Mining
Prerequisite skills:

The decision for selecting the production rate of a new deposit is sometimes guided by Taylor's rule. However, this is based on data that is decades old, so this project seeks to replace it with more modern data, and more criteria

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Durham, Richard, Prof

Multi-objective optimisation of cemented paste backfill design

Disciplines: Mining
Prerequisite skills:

Cemented paste backfill (CPB) has been increasingly used in underground mines around the world as a main support element for more than 30 years. The main performance indicators for CPB are the strength (UCS) and workability in terms of slump (SL) or yield stress. To get the desired performance parameters the key design parameters such as cement percentages (C) and solid content (SC) should be well adjusted. To increase the strength C should be increased but the increased C reduces the workability. Indeed CPB design is a multi-objective optimisation problem. The purpose of this study is to investigate the applicability of multi objective optimisation algorithm/s to adjust key design parameters to get CPB with desired performance indicators. For this purpose the database will be constructed either from the literature or from the mine in WA. Then the constructed database will be used for generating strength and slump predictive model/s. Once the models are constructed they will be used in optimisation algorithm.

Dyskin, Arcady, Prof

Hydraulic fracture production and monitoring

Disciplines: Civil, Materials, Mechanical, Oil & Gas
Prerequisite skills: Finite Element Method

Modelling of hydraulic fractures and their monitoring are important for ensuring economical and environmentally safe hydrocarbon extraction. The project will involve physical and numerical modelling of hydraulic fractures using the laboratory experiments and the finate element modelling.

Dyskin, Arcady, Prof

Sound and vibration absorption in interlocking structures

Disciplines: Civil, Materials, Mechanical
Prerequisite skills: Finite Element Method

The project aims at investigating sound absorption and the resistance against ground vibrations of structures based on interlocking blocks. The project includes the block manufacturing, photogrammetric and acoustic measurements and numerical modelling.

Dyskin, Arcady, Prof

Modelling of subsidence caused by petroleum and mining operations

Disciplines: Civil, Materials, Mechanical
Prerequisite skills: Finite Element Method

The project aims at modelling subsidence caused by reservoir depletion or by driving large underground excavations. The project involves finite element modelling and parametric analysis. The project will also verify the existing simplified models and establish the ranges of their applicability.

Dyskin, Arcady, Prof

Methods of digital construction based on 3D printing of concrete

Disciplines: Civil, Materials, Mechanical, Software
Prerequisite skills: Finite Element Method

This is a literature review project aimed at presenting the state of art in the smart construction methods including various methods of 3D printing of concrete (including fiber-reinforced concrete) and the design software. It is expected that the environmental aspects will be emphasized.

Elchalakani, Mohamed, Dr

Fibre Reinforced Concrete [FRC]

Disciplines: Chemical, Civil. Environmental, Materials, Mechanical, Mining, Oil & Gas
Prerequisite skills: do not mind getting their hand dirty
Fibre reinforced concrete (FRC) which is characterised by high strength and durability when reinforced with steel, glass, or carbon fibres, has the potential to revolutionise the construction industry. The application of FRC is currently limited to replace traditional steel bars with Fibre Reinforced Bars. Producing Concrete this way has its own limitations because the FRP bars have potential problems like fracture of the resin and debonding from the concrete matrix surrounding the bar. The present innovative FRC is it is produced in such away that the fibres are mixed with the concrete without the week resin. An investigation of the axial and compression, tensile and bending strength of the FRC will be compared with normal concrete. It is expected that this concrete will have a significant impact on the construction industry.

Elchalakani, Mohamed, Dr

NEW CONCRETE MADE OF RIVER WATER AND RIVER SAND

Disciplines: Chemical, Civil. Environmental, Materials, Mechanical, Mining, Oil & Gas, Petroleum
Prerequisite skills: do not mind getting their hand dirty

The production of one ton of cement contributes to production of one ton of CO2 which is very harmful to the environment. With the increase in the development of infrastructure projects in marine environment represented in coastal zones of Australia, the need for a durable and sustainable concrete is also increasing. The coal based power plant produces huge quantity of fly ash, which creates its disposal problems. However to some extent, the fly ash is used as partial or recently full substitution to cement to make a promising solution namely, "geopolymer concrete." The alkali activated fly ash and slag geopolymer Concrete shows considerable promise for application in the construction industry as an alternative to the Portland cement for its well-known resistance to acid attack. Day by day the scarcity of silica sand and fresh water is big challenge arising to the construction industry. On the other hand the sea sand is available in huge quantity, but the presence of salt and chloride affects the strength and durability of cement concrete. In present experimental work the river sand and river water will be used as an alternative to silica sand and fresh water to investigate the properties of the newly developed geopolymer concrete. The effects of the river sand and river water on the mechanical strength and durability of geopolymer concrete will be investigated in depth.

Elchalakani, Mohamed, Dr

Strengthening of Lightweight Concrete Structures

Disciplines: Chemical, Civil. Environmental, Materials, Mechanical, Mining, Oil & Gas, Petroleum
Prerequisite skills: highly motivated

High-rise buildings made of lightweight concrete structures have higher resistance to and earthquake because they have lower mass. They have been used in bridge construction for their superior performance under fatigue loading and during fire because of their higher thermal resistance. Currently there are no design rules i international standards for proper design of lightweight concrete structures. This projects aim at developing new design rules for such lightweight structures through experimental testing in the laboratory. Lightweight concrete beams and columns will be tested and their ultimate strength ductility and energy absorption will determined. These beams will be strengthened with ultra-light carbon fibre polymers to further increase their load bearing capacity. The test results will help in developing design equations to be included in future edition of Australian Concrete Code AS3600.

Elchalakani, Mohamed, Dr

TUBULAR FRP SECTIONS AS STRUCTURAL MEMBERS FOR THE RIVER JETTIES AND WALKWAYS

Disciplines: Civil, Environmental, Materials, Mechanical, Mechatronic, Mining, Oil & Gas, Petroleum

Prerequisite skills: do not mind getting their hand dirty

The main aims of this project it to produce 1/3rd scale of existing jetties/walkways by using tubular Fibre Reinforced Polymers (FRP) circular tubes of 100 and 50 mm nominal diameter and then testing their member/joint structural performance under dead and live load in the structural laboratory at UWA. A total of 8 scaled jetty sections (4m long and 1.0 m high) and a total of 8 nodes (1.0 m long and 1.0 m high) will be constructed. All the specimens will be tested to failure to determine their ultimate bearing capacity and to examine their possible modes of failure. In addition, filling the empty tubes with concrete made of river sand and river water can be also examined to produce strong structure with locally available materials. Preliminary design rules will be derived from the limited experimental program. This project is suitable for the students who are interested in structural engineering, mechanics of materials and offshore/coastal engineering.

This project will be done in collaboration with VHM Solutions pty ltd, a company located in Perth with a wide expertise in the oil and gas industry and a major supplier of high quality FRP tubular sections. They will donate the required materials and adhesive for the project. They will work closely with UWA academics and MPE students to deliver practical solutions for the proposed jetties fully made of FRP.

Elchalakani, Mohamed, Dr

The development of Fibre Reinforced Light Weight ultra high performance concrete for high rise buildings

Disciplines: Chemical, Civil, Environmental, Materials, Mechanical, Mechatronic, Mining, Oil & Gas, Petroleum

Prerequisite skills: do not mind getting their hand dirty

This project aims to develop light weight ultra high performance concrete for the construction of high rise buildings in Australia. Ultra-high performance concrete (UHPC) which is characterised by high strength and, when reinforced with steel fibres, high ductility, has the potential to revolutionise the construction industry. The application of UHPC is currently mainly limited to landmark projects due to the high cost of manufacture, which often involve specialist materials such as specially graded sands and the need for complex mixing and curing regimes. Moreover, mix designs are commonly proprietary information or incompletely reported.

As a result of the complexity of material requirements and the restricted nature of complete mix design details it can be difficult to reproduce reported results. This project aims to address these issues by investigating the potential for producing UHPC using widely available fine and coarse aggregates.

Elchalakani, Mohamed, Dr

3D Printing of Concrete for the Housing Market in Australia

Disciplines: Chemical, Civil, Environmental, Materials, Mechanical, Mechatronic, Mining, Software

Prerequisite skills: do not mind getting their hand dirty

Concrete is the most commonly used construction material in the world and therefore, advancements in the manufacturing process can have profound environmental and economic implications. In recent years, significant progress has been made in the additive manufacturing process through the use of 3D printers. The use of 3D concrete printing (3DcP) is expected to reduce CO2 emissions, through producing structures that are materially more efficient in design and economically, 3DcP is expected to reduce labour costs, estimated from 50 to 80% of total construction cost while increasing worker safety making 3DcP at the forefront of industry interest. However, 3DcP faces two major challenges to meet international construction standards that need to be achieved; (i) an optimized concrete composition (referred to as the 3DcP ink in this paper) that
is easily accessible, cost effective, has shape retention and meets strength requirements of standardized concrete; and (ii) the inclusion of steel reinforcement during the printing process or as a post-hoc placement to ensure ductile failure modes with increased capacities to meet building standards.
The purpose of this research paper is to address these two issues separately in an attempt to create an optimized 3DcP guideline for building construction by building on past research from scholarly sources.

Elchalakani, Mohamed, Dr

3D Image for detecting cracking in concrete

Disciplines: Chemical, Civil, Environmental, Materials, Mechanical, Mining, Oil & Gas, Petroleum

Prerequisite skills: love to get their hand dirty

Natural disasters all too often place human lives and property at risk. Recovery efforts following a disaster can be slow and painstaking work, and potentially put responders in harm's way. A system which helps identify defects in critical building elements (e.g., concrete columns and walls) before responders must enter a structure could save lives. In this project we propose such a system, centered around an image-based three-dimensional (3D) reconstruction method and a new 3D crack detection algorithm. The image-based method is capable of detecting and analyzing surface damages in 3D. We also demonstrate how a robotic platform could be used to gather the set of images from which the reconstruction is created, further reducing the risk to responders. In this regard, image-based 3D reconstructions represent a convenient method of creating 3D models because most robotic platforms can carry a lightweight camera payload. Additionally, the proposed 3D crack detection algorithm also provides the advantage of being able to operate on 3D mesh models regardless of their data collection source. The perceived benefits of the proposed method in a post-disaster situation is most needed for Australian aging infrastructure.

Faiello, Cosimo, Associate Professor

Sustainability applied to project management & engineering practice

Disciplines: Chemical, Civil, Electrical & Electronic, Environmental, Mechanical, Mechatronic, Mining, Oil & Gas, Petroleum

This topic will introduce students to the field of project management and engineering practice with a focus on achieving sustainable results based on a "triple bottom line" (TBL) approach: That is, achieving project objectives, while taking into account the societal and environmental implications of a project. A sustainable approach to project management and engineering practice is recognised globally by many organizations, as being vital to achieving their strategic objectives. By researching this topic students will learn how to apply theoretical concepts and frameworks to 'real world projects' in order to achieve sustainable outcomes using a TBL strategy.

Fernando, Tyrone, Professor

Co-supervisors: Iu, Herbert, Professor

Control Strategy of DFIG Wind Turbines for Power System Fault

Disciplines: Electrical & Electronic

Prerequisite skills:

Doubly fed induction generator (DFIG) is a popular wind turbine (WT) system due to its high energy efficiency, reduced mechanical stress on the WT, and relatively low power rating of the connected power electronics converter of low costs. With increasing penetration level of WTs into the grid, the wind power grid connection codes in most countries require that WTs should remain connected to the grid to maintain the reliability during and after a short-term fault. The ability of WT to stay connected to the grid during voltage dips is termed as the low-voltage ride-through (LVRT) capability. The aim of this project is to develop a control strategy for both the rotor and grid side converters to enhance the LVRT capacity of the DFIG WT.

Fernando, Tyrone, Professor

Co-supervisors: Iu, Herbert, Professor

Power Management and Control Incorporating Renewable Energy

Disciplines: Electrical & Electronic

Prerequisite skills:

An investigation to power management and control incorporating renewable energy sources, micro grids and batteries. It is likely and desirable for homes, companies and suburbs to incorporate battery storage for power generated by renewable sources, such as solar panels. A control system designed to optimize energy contributions to local storage, selling to the grid and micro-grid batteries is desired.

Fernando, Tyrone, Professor

Load Flow Analysis of Microgrids

Disciplines: Electrical & Electronic

Prerequisite skills:

Power flow studies of conventional power grids are based on classifying the network busses intron three types: (1) Slack bus, (2) Generator busses and (iii) Load busses. It is reasonable to assume the existence of a slack bus in a conventional power generation system with sufficient capacity to balance the supply and demand of power. However, in microgrids such an assumption may not be valid, hence the power flow analysis need to be modified.

Fernando, Tyrone, Professor

Co-supervisors: Iu, Herbert, Professor

Stability Analysis of a DFIG Wind Turbine System

Disciplines: Electrical & Electronic

Prerequisite skills: MatLab programming

Presently there is a global concern about the economic downturn and a green earth which in turn is related to a better and efficient method to generate and transmit electric power. Wind energy systems are becoming popular. Doubly fed induction generator (DFIG) is a popular wind turbine system due to its high energy efficiency, reduced mechanical stress on the wind turbine, and relatively low power rating of the connected power electronics converter. The DFIG is also complex involving aerodynamical, electrical, and mechanical systems. With increasing penetration level of DFIG-type wind turbines into the grid, the stability issue of DFIG is of great importance to be properly investigated. The aim of this project is to study the small signal stability of the DFIG wind turbine system.

French, Tim, Dr

Knowledge graph construction from uncertain and incomplete data

Disciplines: Biomedical, Chemical, Software

Prerequisite skills: Software

General game playing is a challenge in Artificial Intelligence to build a general approach to playing games that isn't dependent on hand built heuristics or tailored algorithms. This project will ivestigate and implement some recent automated reasoning techniques in the context of general game playing agents.

French, Tim, Dr

Co-supervisor: Hassan, Mubashar, Dr

Autonomous driving protocols for remote control vehicles

Disciplines: Electrical, Mechanical, Software

Prerequisite skills: Strong programming skills (>70% in CITS1001, CITS1401, >80% in CITS2401)

The tabletop autonomous car simulator uses micro-computers, real-time video, and bluetooth control toy vehicles to simulate autonomous driving procotols. In this project, students will develop driving protocols and optimise the infrastructure with the aim of matching human performance.

Fridjonsson, Einar, A/Prof

Johns, Mike, Prof

Industrial Water Management

Disciplines: Chemical, Environmental

Projects are available across a range of industrial water management topics:

(i) Desalination and waste water treatment are areas of growing global importance (47% of Perth's water now comes from desalination!). Membranes are important for the separation of contaminants from liquids across a range of industrial processes. A critical issue with membrane separation is fouling, projects are available on membrane fouling, forward osmosis and the development of an NMR-based clamp-on monitoring technology.

(ii) Project are available on nanofluids which have the potential to substantially reduce both the OPEX and CAPEX and water usage of heat exchange processes for LNG production facilities.

Fridjonsson, Einar, A/Prof

Graham, Brendan, Dr

Renewable Energy (Li Battery technology – economic life cycle analysis)

Disciplines: Chemical

With immense interest in the development of the full range of the Li battery production chain in Australia (from raw material to batteries). This project will focus on analysing the value chain in Lithium battery technology (from mine to battery to recycling) and evaluating opportunities for process PFD improvements to full life-cycle economic analysis.

Gendre, Bruce, Dr

GRBase, a database of transient events

Disciplines: Software

Prerequisite skills:

Nowadays, the astronomy can be classified into two broad categories: transient astronomy and pointed astronomy. The former is the science of observations of varying events, present in the sky for only a given amount of time. Ten years ago, the project GRBase was created in view to store all these observations and the related information into a single place. However, the project never reached its full capacity due to the lack of a few components. The subject of this internship is to provide the seeds of the lacking components, and an update of the other programs used by GRBase. The students will work on Data Mining issues and automation of Data Extraction; on web interfaces and web portal design; on database optimisation and maintenance; and on Data visualisation using the latest new technologies. Such skills are highly requested our connected world, and are part of the basic skills needed to work for any big internet company.

Ghadouani, Anas, Prof

Microplastics in the urban water cycle

Disciplines: Chemical, Civil, Environmental, Mechanical
Prerequisite skills:
Microplastics are a growing area of concern in the water cycle. This project could involve the characterisation, fate and transport of microplastics through wastewater, stormwater, and environmental flows. This project may involve lab tank experiments and/or microscopy.

Ghadouani, Anas, Prof

Improving performance of wastewater treatment assets

Disciplines: Chemical, Civil, Environmental, Mechanical
Prerequisite skills: Hydraulics/modelling useful

Selected topics from industry based on-going investigations into improving performance/optimisation of pond-based wastewater treatment assets, including greenhouse gas mitigation, biosolids treatment and reuse, and hydraulic/treatment performance. This may include computer modelling, data collection and analysis and/or lab work.

Ghadouani, Anas, Prof

Smart urban water systems for future cities

Disciplines: Civil
Prerequisite skills:

This project revolves around the integration of ecological engineering principles in the design and management of water infrastructure of cities. This could include smart solutions for new cities, or innovative solutions for current cities.

Ghisalberti, Marco, Dr

Co-supervisors: Abdolahpour, Maryam, Dr.

Characterising material transport from Swan River sediments

Disciplines: Civil, Mechanical, Biomedical
Prerequisite skills: Some fluid mechanics/hydraulics coursework experience.

This project addresses a fundamental, unanswered question in our efforts to sustainably manage water quality in the Swan River: "How important are the sediments?". Aquatic sediments can represent a predominant source of nutrients for the water column. However, our inability to quantify the interaction between the sediments and overlying (and highly dynamic) water column remains a critical barrier to improved modelling and management of water quality in the river.

This project utilises a novel fluid mechanics methodology, Refractive Index Matching, to allow measurement of flow-driven material transport across the sediment-water interface in the laboratory. The contribution of sediments to sustaining nutrient pollution in the river, and its variability in space & time (to understand hot spots & danger periods), will be determined.

Ghisalberti, Marco, Dr

Computational fluid dynamics simulations to enable student learning

Disciplines: Civil, Mechanical, Chemical, Biomedical
Prerequisite skills: Some fluid mechanics/hydraulics coursework experience.

As part of the EZONE development, UWA will have a new, world-class Hydraulics teaching laboratory in 2020. To complement the physical experiments, unit coordinators of fluid mechanics units at UWA are looking to provide students with the results of high-resolution computational fluid dynamics (CFD) simulations to allow them to compare observed phenomena in the laboratory to the 'theoretical' prediction. This will be an essential part of the laboratory learning experience for future students.

This project will allow students to use state-of-the-art software to create CFD simulations of canonical fluid mechanics phenomena, such as the Kelvin-Helmholtz instability, hydraulic jumps, turbulent pipe flow and gravity currents. These simulations will be constant display within the EZONE Hydraulics Laboratory, and an integral part of fluid mechanics teaching at UWA.

Gong, Peijun, Dr

OBEL: Non-invasive optical imaging of blood and lymphatic vessels

Disciplines: Biomedical, Electrical & Electronic, Mechanical, Software

Prerequisite skills: Signal/image processing or computer programming

In OBEL (http://obel.ee.uwa.edu.au/) , we have been working on the development of non-invasive optical imaging of blood and lymphatic vessels in humans – which is important in skin scarring and healing, diabetes, and in retinal diseases. This project will involve further development of these imaging methods, capturing images, and improving data analysis techniques to segment the blood and lymphatic vessels. As a step toward clinical applications, the effectiveness of the data analysis techniques on human clinical data will also be investigated. Students are expected to have knowledge or interest in image processing, electronics or computer programming. Come and talk to us about this project.

Graham, Brendan, Dr

Fridjonsson, Einar, A/Prof

Comparison of hydrogen and ammonia as green fuels

Disciplines: Chemical

Hydrogen and ammonia are being touted as both green fuels and as ways to store useful energy out of excess renewable energy generation (wind and solar) through their production

and later use. This project will focus on the lifecycle analysis of the use of these fuels through generation, distribution, end uses (electricity generation, fuels, energy storage), considering the technological demands of the associated processes, energy efficiency, economics and the applicability to the current and future Western Australian market.

Guzzomi, Andrew, Dr

Agricultural Engineering Innovation

Disciplines: Mechanical, Software

The AgEngineering group at UWA works with leading industry to deliver innovative implementable solutions to increase yields and profitability. Some examples include: the Weed Chipper technology (Finalist in WA Innovator of the Year) for broad-acre cropping to overcome herbicide resistance, the patented flash-flaming technology (winner WAIOTY 2016) to improve restoration and novel mechanised solutions including robotics; projects developing innovative solutions to increase seed harvesting efficiency and reduce environmental damage; projects that develop new fertilizer products; AI and machine learning for on-farm use; etc.

These interdisciplinary (e.g. co-supervised by leading scientists) project cover analytical modelling, simulation (DEM, CFD and multi-physics models), experiments and design.

This is an exciting opportunity to join a dynamic, award winning and very well-funded group that is considered state-of-the-art in Agricultural Engineering Innovation.

Hill, Martin, Assco/Prof
Co-supervisors:

Active plasmonic photonic crystal structures

Disciplines: Electrical & Electronic

Prerequisite skills: Maxwells equations (ELEC4401 or equivalent), Linux, C

Looking at photonic crystal concepts applied to plasmonics and particularly looking at structures which will allow electrically pumped gain medium. Project involves using finite difference time domain (FDTD) simulations of Maxwell's equations to check any theorectial results.

Hill, Martin, Assco/Prof
Co-supervisors:

Textured metallic surfaces for near IR nano cavity size reducti

Disciplines: Electrical & Electronic

Prerequisite skills: Maxwells equations (ELEC4401 or equivalent), Linux, C

Look at effects of texture on metal surfaces with the aim of reducing the effective wavelength of plasmons in a cavity. In particular, seeing if spoof plasmon concepts used in the THz regime could be useful in the near infra-red (IR).

Hodkiewicz, Melinda, Prof

Polpo de Campos, Adriano, A/Prof

Reliability analysis for asset performance improvement

Disciplines: Chemical, Electrical & Electronic, Mechanical, Mining

Prerequisite skills: Strong statistics/ maths skill set . At least 75% in GENG5507 (Risk Reliability and Safety) and some additional stats units or for those who have not done this unit yet a good performance in 2nd and 3rd year maths, statistics or econometric units. Must be comfortable with calculus and be prepared to learn R.

There is a need for competent application of statistical skills to support reliability and performance analysis of asset health as part of opportunities offered by predictive maintenance. These projects will work with industry data sets to to develop data sets appropriate for machine learning, statistical or bayesian inference and prediction methods and present the results to industry.

Hodkiewicz, Melinda, Prof

Liu, Wei, Dr & French, Tim, Dr

Semantics for industry data

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Requires >75% in any of CITS2001, 2200, 3001, 3002 or 4404.

Must be competent in Python.

We are working with resources companies to automate the processing of unstructured text found in maintenance and inspection reports. These reports capture information about the health of the asset and are vital in assessing the reliability of the equipment. This is an exciting and growing area of interest from companies.

This project is for CSSE students or computer literate EEs (or other disciplines) with the right experience who are doing an MPE.

Hodkiewicz, Melinda, Prof

Dr. Ben Travaglione (Adjunct Prof)

IIoT Edge Computing

Disciplines: Electrical & Electronic, Software

Prerequisite skills: MECH4424 (Measurement and Noise) or ELEC4404 (signal processing) with >70%. Scientific computing (MatLab, Mathematica, SciPy, R) and a willingness to learn Python. Electronic/Microcontroller experience would be well regarded.

The cheap commercial off-the-shelf (COTS) MEMS sensors found in your cars and phones are now making inroads into industrial applications for monitoring infrastructure and assets in the resources sector. However our understanding of their reliability and performance relative to traditional sensors is still developing. The UWA System Health Lab (https://systemhealthlab.com/) have developed a number of Industrial Internet-of-Things (IIoT) devices, utilising a variety of different microcontrollers and sensors to explore issues with industrial applications. In 2020 we are looking for a student to install a bespoke IIoT device into an industrial spare part and use edge computing to measure when the part is moved and the forces it experiences.

Hodkiewicz, Melinda, Prof

Dr. Ben Travaglione (Adjunct Prof)

MEMS piezo microphone beamforming

Disciplines: Electrical & Electronic, Software

Prerequisite skills: MECH4424 (Measurement and Noise) or ELEC4404 (signal processing) with >70%. Scientific computing (MatLab, Mathematica, SciPy, R) and a willingness to learn Python. Electronic/Microcontroller experience would be well regarded.

An array of microphones can be used to localise a sound source in much the same way as our brains process sounds from our two ears to localise a sound. These microphone beamforming techniques can be applied to industrial asset management situations, where a change in the noise output of an asset is often the first indication of asset degradation. The UWA System Health Lab (https://systemhealthlab.com /) is investigating the use of rugged, cheap commercial off-the-shelf (COTS) MEMS piezo microphones for monitoring of industrial infrastructure and assets in the resources sector. These MEMS piezo microphones are very new and our understanding of their reliability and performance relative to traditional microphones is still developing. In 2020 we are looking for a student to extend the development of a digital piezo MEMS microphone array and explore the edge computing requirements of such an array.

Hodkiewicz, Melinda, Prof

Sercombe, Tim, Prof

Experimental work - UV degradation of 3D printed parts

Disciplines: Electrical & Electronic, Mechanical

Prerequisite skills: There is a large test component in this project so the students will need to have a strong practical and time management skills. You will need to do laser, Instron, and microscopy training. You will learn a lot of skills and work with a good team but will need to dedicate at least one day a week to this project throughout both semesters. We suggest you only consider this if you have >70% in core Materials units as there is a strong technical component. There are two previous projects on this if you need more information.

2017, 2018 and 2019 the System Health Lab developed testing facilities for comparing the UV degradation of 3D printed vs machined nylon. The 2020 project will continue this and involve experimental design, procurement, test execution, tensile testing and microscopy of samples degraded using facilities on the roof and an accelerated test facility. See a You Tube video of the project at https://www.youtube.com/watch?v=FbdY_w7grlk& and poster outside System health Lab 1.53 in Mech Eng.

Hong, Jin, Dr.

Liu, Wei, Dr.

Generating rumours using machine learning

Disciplines: Software

Prerequisite skills: This project is intended for a multidisciplinary team of up to 3 students. Applicants will require skills in one or more of the following areas: artificial intelligence, machine learning, natural language processing, programming, data analysis (collection, analysis, visualisation etc).

Millions of people share information on social networks every day, which also allow false information (e.g. rumours) to spread rapidly and mislead users. For instance, rumors affected political decisions, stock market, people's actions during natural disasters, and the safety during accidents/terrorism. Various machine learning (ML) models are proposed for rumour detection, but correctly identifying them is still a challenge. To improve rumour detection, we can support the detection classifier by generating a conflicting data to learn stronger rumour indicative representations, which then can be used to distinguish more challenging rumour data. In this project, student(s) will (1) evaluate the effectiveness of rumour detection techniques using ML, (2) implement rumour generation framework, and finally (3) evaluate the effectiveness of rumour detection used with the rumour generation framework.

Reading:
https://www.researchgate.net/profile/Wei_Gao56/publication/331274372_Detect_Rumors_on_Twitter_by_Promoting_Information_Campaigns_with_Generative_Adversarial_Learning/links/5c711abb92851c6950397372/Detect-Rumors-on-Twitter-by-Promoting-Information-Campaigns-with-Generative-Adversarial-Learning.pdf

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Hong, Jin, Dr.

Intrusion detection and mitigation using AI and ML

Disciplines: Software

Prerequisite skills: This project is intended for a multidisciplinary team of up to 3 students. Applicants will require skills in one or more of the following areas: artificial intelligence, machine learning, programming, data analysis (collection, analysis, visualisation etc).

Intrusions are increasing as the networking technologies advance and more devices are connected over the Internet. Intrusion detection systems (IDS) can be used to detect them and plan for mitigations, but it is practically impossible to detect all types of attacks. With the use of artificial intelligence (AI), we can still improve the detection mechanism and success rate of detecting various types of attacks. This project aims to investigate how different AI techniques perform when used for intrusion detections. Tasks involved in this project are (1) to survey latest intrusion detection techniques, (2) implement them and compare their intrusion detection rate, (3) implement new/improved AI system for the intrusion detection and evaluate the effectiveness.

Recommended reading: Nabil Ali Alrajeh and J. Lloret "Intrusion Detection Systems Based on Artificial Intelligence Techniques in Wireless Sensor Networks", International Journal of Distributed Sensor Networks, 2013, https://doi.org/10.1155/2013/351047

Hong, Jin, Dr.

Cybersecurity gamification for students

Disciplines: Electrical & Electronic, Software

Prerequisite skills: This project can be carried out as an individual or a team of up to 2 students. Applicants will require skills in one or more of the following areas: cybersecurity, game development, programming, data analysis (collection, analysis, visualisation etc).

Can we learn through playing games? Education topics have been converted and incorporated into games to teach players the concepts and ideas, such as mathematics, learning words, trivia etc. The process of turning education into games is called gamification, which is different to games which are developed with main focuses on enjoyments. Cybersecurity can also benefit from gamification, where difficult concepts in security can be taught to students through different tasks through the game. This project aims to develop and gamify cybersecurity topics and evaluate the learning experience of students particularly for high school students to ignite their interest in cybersecurity. Tasks involved are (1) to survey cybersecurity games and categorise them, (2) develop new cybersecurity game to fill the gap in the literature or to improve limitations, (3) conduct field study to compare and evaluate the usefulness of cybersecurity gamification.

Hong, Jin, Dr.

Adaptive moving target defence for dynamic networks

Disciplines: Software

Prerequisite skills: This project can be carried out as an individual or a team of up to 2 students. Applicants will require skills in one or more of the following areas: cybersecurity, programming, data analysis (collection, analysis, visualisation etc).

Moving target defence (MTD) is a method to continuously shift attack surface to thwart cyber attacks. This differs to traditional defence approaches where vulnerabilities are patched/removed. MTD techniques introduce uncertainly in network configurations, which confuses attackers to carry out a set of attacks that may no longer be valid. The problem we face today is that our networks are also dynamic (e.g. the cloud, SDN, IoT). Such changes also affect the effectiveness of MTD techniques. This project will explore how the security posture affects the effectiveness of MTD techniques in detail, and explore ways to configure MTD techniques to minimise the disruptions caused by dynamic network changes. The goal of this project is to investigate: 1) evaluating the effectiveness of MTD techniques when changes are introduced in the network, 2) measure the effectiveness variant for different types of changes, and 3) develop adaptive MTD technique configuration to minimise the disruptions of its application when dynamic changes are observed in the network.

Howell, Eric, Dr

Gravitational wave searches for radio transients

Disciplines: Software

Prerequisite skills:

Fast Radio Bursts (FRBs) are bright, millisecond duration radio transients whose origin is not known. From around 100 observations so far, it is clear that what they are is a highly debated subject. The LIGO/Virgo gravitational wave observatory will have access to 100s of recently discovered FRB data to search for counterpart gravitational wave signals. As part of the LIGO GRB/FRB sub-group this project will allow students to become involved in real searches as a member of LIGO for unknown phenomenon. It is quite possible that searches can yield valuable new clues to these enigmatic bursts over the next couple of years.

Hu, Xiaozhi, Prof

Hu, Yunsen, PhD

High strength, high toughness and high modulus carbon fiber composites

Disciplines: Civil, Mechanical

Prerequisite skills: A good understanding of materials and mech. design

Carbon fiber composites can only retain around 70% of properties of carbon fibers due to low strength, low toughness and low stiffness of epoxy matrix (around 35 vol%). We will test various composite microstructure designs to minimize the reduction of composite properties.

Hu, Xiaozhi, Prof

Chen, Yi, PhD

Verification of simple design model using samples with shallow cracks

Disciplines: Civil, Mechanical

Prerequisite skills: A good understanding of materials and mech. design

Non-destructive-testing can detect a fatigue crack as short as 0.5 mm. According to ASTM standard, the fracture toughness criterion used for Linear Elastic Fracture Mechanics is not applicable to metal structures with shallow cracks. We will test a new design method developed at UWA.

Hu, Yuixa, Prof.

Helical pile foundation for offshore wind turbines

Disciplines: Civil, Software
Prerequisite skills: Numerical analysis using existing software-ABAQUS/Plaxis

To support offshore wind turbines, mono-pile is still the dominating type of foundation. Helical piles have the potential to increase the foundation efficiency and economy. This project is to look at the bearing capacity of helical piles using numerical analysis.

Hu, Yuixa, Prof.

Pavement engineering and Perth sands

Disciplines: Civil
Prerequisite skills: Civil engineering/geomechanics

Waste recycling in Australia is facing challenges as we can't sell them to other countries. To create a circular economy, we need to be able to recycle them for new infrastructure projects, such as pavement. This project will look at the potential of recycling waste in pavement design.

Perth sands may behave differently before and after compaction, and the design may be based on their characteristics before compaction.

Both projects are laboratory based testing.

Pavement reinforcement using geogrid – numerical analysis (may involve field trials)

Huang, David, Professor

3D tomographic retrieval of the atmosphere using LEO satellite signals

Disciplines: Biomedical, Electrical & Electronic, Mechanical

Several companies in the world plan to deploy low earth orbit (LEO) satellite constellations to provide global Internet services. For example, SpaceX plans to deploy about 12,000 satellites; OneWeb successfully launched the first 6 of the 648 planned satellites on February 27, 2019. All those LEO satellites use microwave signals.

On the other hand, the attenuation of microwave signals due to the atmosphere could be utilized to measure the atmosphere. Similar to using X-ray to carry out human-body CT scans, using the microwave signals from the LEO satellites, it is possible to achieve three dimensional tomographic retrieval of the atmosphere, with resolutions never achieved before, thereby making many applications possible, e.g. real-time 3D retrievals of tornados and thunderstorms. In this project, you will research into one or two advanced signal processing techniques for making such retrievals possible.

Huang, David, Professor

Technologies for Next Generation Communication Systems

Disciplines: Electrical & Electronic

Next generation communication systems are expected to meet various requirements, e.g. high data rate, low latency, and high reliability, leading to lots of challenges to be solved. In this project, you will research into one or multiple technologies that have great potentials to be used in next generation communication systems to solve those challenges, including (but not limited to):

1. Edge Computing

2. Millimeter wave

3. Massive MIMO

4. Ultra reliable communications

5. Small cell

6. Low earth orbit satellite communications

7. Visible light Communications

Huang, Yimiao, Dr

Application of Smart Structural Design and Construction Methods for Current and Future Engineering Practices

Disciplines: Chemical, Civil, Environmental, Mechanical
Prerequisite skills:

In recent years, the ways of structural design and construction have been changed dramatically. Newly developed technologies such as Building Information Modelling (BIM), Artificial Intelligence (AI), and 3D printing have been widely applied in civil engineering. In the present project, students will learn to use one or more of those advanced design and construction methods and apply them in engineering practices. The sub-topics includes 'Building Information Modelling (BIM) based Construction Design', 'Artificial Intelligence (AI) based Building and Material Optimisation', '3D Concrete Printing Research', etc.

Iu, Herbert, Professor

Development of nonlinear circuits with mem-elements

Disciplines: Electrical & Electronic

Prerequisite skills: MatLab, Spice, hardware

This project proposes focus building chaotic circuits and systems with mem-elements. A universal interface circuit, which when connected to different peripheral circuits, can construct the fundamental mem-elements: memristors, memcapacitors and meminductors, with inexpensive off-the- shelf circuit components. While mem-element emulators and their associated mutators exist in abundance, many of them are severely limited in functionality. Mem-elements are able to build a large variety of circuits that exhibit nonlinear behavior. These circuits are thoroughly studied and analysed.

Jiang, Hongyi, Dr.

Flow characteristics in the wake of a cylindrical object of a square cross-section

Disciplines: Civil
Prerequisite skills:
Steady incoming flow past a slender cylindrical object has been a classical problem in fluid mechanics for over one hundred years, owing to its fundamental significance as well as practical applications in the fields of civil, mechanical, hydraulic, offshore and wind engineering. Despite its geometric simplicity,

rich flow phenomena and flow physics have been discovered, including flow separation and vortex shedding from the body, wake flow transition from two-dimensional to three-dimensional states, flow transition from laminar to turbulence, etc.

This project aims at investigating the flow around a cylindrical object with a square cross-section at various flow incidence angles. The influence of the incidence angle and the Reynolds number on the wake flow patterns and hydrodynamic forces on the body will be accurately quantified through well-designed numerical simulations (which is free from any disturbances or uncertainties that may come with physical experiments). Interesting wake flow patterns will be observed and their formation mechanisms will be analysed. The numerical simulations will be conducted by remotely accessing the cutting-edge Pawsey supercomputing facilities. An Ubuntu operating system is required on the local desktop/laptop for case generation and analysis.

This project is suitable for students who are interested in computational fluid dynamics (CFD) and fluid mechanics. Based on weekly meeting with the supervisor, students will be familiarised with the workflow of numerical modelling (from mesh generation, case setup and running to data analysis). It will be a good start for students who (i) intend to do industrial design through numerical modelling, or (ii) aim at pursuing a PhD degree in fluid mechanics at a later stage.

Johns, Mike, Prof

Connolly, Paul Mr; Fridjonsson, Einar. A/Prof

Benchtop NMR for Honey Quality Control

Disciplines: Chemical, Mechanical

Recent media reports have detailed the use of high field Nuclear Magnetic Resonance (NMR) to check for illegal adulteration of (Australian) Honey with various sugar solutions. This however requires superconducting magnets which are expensive, immobile and not widely accessible. The project will further extend a novel quality control protocol, developed at UWA, for such honey monitoring using a mobile, benchtop NMR spectrometer. It will explore increasing its sensitivity to a wider range of adulterants.

Johns, Mike, Prof

Ling, Nick Mr; Fridjonsson, Einar. A/Prof

Monitoring of Water-MEG ratio in the Natural Gas Industry

Disciplines: Chemical, Mechanical

Mono-ethylene glycol (MEG) is widely used in Western Australia to prevent hydrate formation in pipelines enabling sub-sea natural gas production. This MEG is required to be separated from produce water and recycled, hence monitoring of the water-MEG ratio is critical. This project will extend a benchtop NMR method to determine the water-MEG ratio

in the presence of MDEA, salt and various pH control additives. Such additives are very detrimental to alternative measurement options.

Johns, Mike, Prof

Robinson, Neil, Dr; Fridjonsson, Einar. A/Prof

Peculiarities of Hydrogen Liquefaction

Disciplines: Chemical, Electrical, Mechanical

Hydrogen is experiencing a rapid renaissance as a renewable energy storage method; export is likely to be in the form of liquid hydrogen. Quantum physics however is remarkably relevant to this liquefaction process as an 'ortho to para' hydrogen conversion that occurs as hydrogen is cooled is exothermic, in fact the heat of this conversion exceeds the latent heat and rapidly liquefied hydrogen will simply revert to its gaseous form! This project will consider the mechanisms whereby this transition occurs as well review the literature on available catalysts to speed up the 'ortho to para' transition.

Jones, Isabelle, Dr

Zhang, Dongke, Prof

Zhang, Zeno, Mr

Spent tyre and its pyrolysis chars as alternative reductant for steel making process

Disciplines: Chemical, Mechanical

Spent tyres discarded in Australia amounts to more than 400,000 tonnes per annum. Being highly flammable, rich in sulphur and capable of releasing polyaromatic hydrocarbons (PAH) and other toxins if burnt uncontrolledly, spent tyres in landfills and stockpiles pose serious environmental hazards and health risks. At the same time, Australia also has large amount of high iron content but very fine iron ore resources in stockpiles. This project aims to utilise spent tyre and its char produced from pyrolysis process as alternative reductant for steel making process.

Sub-project 1: cofiring of spent tyre char and anthracite under pulverised coal injection (PCI) conditions

The objective of this sub-project is to understand the in-furnace phenomena of cofiring spent tyre char and anthracite using a drop tube furnace. The effect of furnace temperature, blending ratio on the ignition and combustion behaviours will be studied. The reactivity of these two feedstock will be measured.

Sub-project 2: Making carbon composite briquette (CCB) using spent tyre char and fine iron ore

The objective of this sub-project is to determine the efficacy of using spent tyre char as the carbon source to make carbon composite briquette for steel making. The briquettes will be prepared using iron ore, char, lime, a binder. The effect of blending ratio, carbonisation temperature and heating rate on the CCB carbonisation behaviour and also the characteristics of the CCB products will be studied.

Sub-project 3: Cokemaking using the briquette of spent tyre and low rank coal

The objective of this sub-project is to investigates the pyrolysis behavior of spent tyre and low rank coal briquette and determines the optimal pyrolysis conditions to produce char from this briquette as a potential reductant for metallurgical applications. The effect of blending ratio, pyrolysis temperature and heating rate on the pyrolysis behaviour and also the characteristics of the char produced will be studied.

Jones, Nicole, Assoc Prof

Predicting circulation under climate change on the Great Barrier Reef

Disciplines: Biomedical, Chemical, Civil, Environmental, Mechanical
Prerequisite skills: Strong programming skills (Matlab, Python). Interest in fluid mechanics

The Great Barrier Reef is under pressure from a number of sources such as river run off, infestation by coral-eating starfish, and climate change. Protecting the coral reefs and mitigating the impact of climate change depends on our understanding about the future of marine environments of the GBR. In this study we will investigate the large-scale atmosphere and ocean circulation changes in the next one hundred years in the GBR under the IPCC climate change scenarios, using high-resolution numerical models.

Ju, Li, Prof

Tilt sensor for seismic isolation of gravitational wave detectors

Disciplines: Electrical & Electronic, Mechanical, Mechatronic

Prerequisite skills: Mathematica/ Matlab, some knowledge of vibration isolation, experimental skills

This project is to characterise a very sensitive tilt sensor, which is needed to improve the sensitivity for gravitational wave detectors. The tilt sensor features a novel 3-D flexure combined with an optical walk-off sensor. This will allow for mounting in all possible degrees

of freedom and provide excellent sensitivity, respectively. The student will be working on the integration, characterising and testing of the system to determine the performance.

Karrech, Ali, Associate Professor

Stability of rammed earth

Disciplines: Civil, Materials, Mechanical
Prerequisite skills:
Sustainable built environments are attracting increasing interest in modern cities given the raising awareness of construction footprint. Conventional construction mainly relies on concrete, the most consumed manufactured material on earth (three tonnes per person per year). According to the US Geological Survey, cement production to make concrete has almost doubled between 2006 and 2016 (from 2 to 4.5 billion tons). Conventional concrete requires about 180 kg of carbon dioxide, a potent greenhouse gas, per tonne of concrete (since 900 kg of CO_2 are emitted to manufacture every ton of cement). This is considered excessively polluting and compromising to the prosperity of future generations.

Rammed earth is one of the viable alternatives to conventional concrete since it can reduce considerably the need for cement. Even when stabilisation is required, smaller amounts of cement are necessary to obtain acceptable strength.

The purpose of this project is to make natural-fibre-reinforced rammed earth materials and test them under various mechanical loading conditions. Rammed earth specimens will be manufactured in the structure laboratory by mixing crushed limestone, water, cement (small amount), and natural fibres. The obtained specimens will be stored under ambient conditions for various durations (3, 7, 14 and 28 days) and tested using a uniaxial loading machine to deduce the Young modulus, Poisson's ratio and Unconfined Compressive Strength of each specimen. The procedure will be repeated by varying the volume fraction and dimensions of fibres.

Karrech, Ali, Associate Professor

Recycling/Urban mining of depleted lithium-ion batteries

Disciplines: Chemical, Environmental, Materials, Mechanical, Mining
Prerequisite skills:
Lithium-ion batteries (LIB) power modern technologies including as laptops, tablets, smart phones, and electric vehicles. The current LIB waste generated in Australia is about 5702 tonne/annum with a growth of about 20% due to the increasing demand and uptake of portable and rechargeable batteries. Only 2% of these materials are collected and exported and the rest is disposed in landfill. However, according to a recent report by CSIRO, "battery waste has potential recoverable value of between $AUD 4,550 and $AUD 17,252" as of March 2018.

The purpose of this project is to collect, dismantle, and process depleted lithium-ion batteries using an established process that has been investigated and tested by the supervisor. The process allows to extract metals such as lithium, cobalt, manganese, nickel under specific conditions of temperature, pH and lixiviant compositions. During this project, the concentration of lixiviant, processing time, and temperature will be varied to optimise the process.

Karrech, Ali, Associate Professor

Geopolymers to up-cycle mineral processing wastes

Disciplines: Civil, Materials, Mechanical
Prerequisite skills:
Geopolymers are alumino-silicate materials with amorphous micro-structures. They are

formed by geopolymerisation processes in which the silicon oxides and aluminum oxides and are activated in alkaline solutions to produce 3D polymeric chains. Geopolymers have the potential to replace ordinary Portland cement (OPC) as construction materials because of their superior cementitious properties and advantageous environmental footprint (geopolymers require approximately 80% lower CO_2 emission than concrete).

The purpose of this project is to make geopolymer materials and test them under various mechanical loading conditions. Geopolymer specimens will be manufactured in the structure laboratory by mixing waste alumino-silicates, sodium hydroxide, water glass, and water in standard proportions. The obtained specimens will be stored in a humidity-controlled room for various durations (3, 7, 14 and 28 days) and tested using a uniaxial loading machine to deduce the Young modulus, Poisson's ratio and Unconfined Compressive Strength of each specimen. In addition, thermal properties such as thermal conductivity and heat capacity will be estimated experimentally.

Kim, Youngho, Dr

New Shape of Dynamically Installed Anchors (DIAs)

Disciplines: Civil

Prerequisite skills: Basic knowledge of geotechnical engineering principles.

Dynamically Installed Anchors (DIAs) are a recent type of mooring technology in deep water sediments. These anchors are released from a designated height above the seafloor, causing the anchor to penetrate into the seabed by the kinetic energy obtained through 'free-fall' and through the self-weight of the anchor. The motivation of this project has emanated directly from the need identified by the offshore industry in an attempt to extend the application of DIAs in untested environments. Therefore, the main objective is to develop the new DIA shapes to be measured with which performs the most effectively, with installation depth and diving performance, as well as cost efficiency in design.
The project will investigate the behaviour of a new shape - DIA using Finite Element Method (FEM). This project would be suitable for students interested in practical applications of geotechnical engineering, particularly when applied to the deep sea developments.

Kim, Youngho, Dr

Co-supervisors: Muhammad Shazzad Hossain, Dr.

On-bottom Stability of Cryogenic Pipelines for Liquefied Gas

Disciplines: Civil

Prerequisite skills: Basic knowledge of geotechnical engineering principles.

The transportation of liquefied natural gas (LNG) requires a pipeline system to transfer LNG between floating tankers and the onshore plant. Cryogenic pipelines have to cope with inner cryogenic temperatures (-160oc), maintain ambient temperature outside and provide sufficient strength so as not to fail. This novel subsea pipeline system will remove the trestle, terminal and long breakwater wall and shift the terminal further off the coast and into deeper 20-50 m waters. The corresponding cost saving may be as high as 60%. The challenge is now for civil engineers to develop design tools for this new pipeline, which is heavier and stiffer compared to conventional pipelines.
The project will investigate the behaviour of cryogenic pipelines in sand (e.g. on-bottom stability) at different embedment depths and operational loading conditions using physical (e.g. centrifuge tests) and numerical modellings (e.g. finite element method).
This project would be suitable for students interested in practical applications of geotechnical engineering, particularly when applied to the offshore plant developments.

Leggoe, Jeremy, Prof

Vortex Induced Vibration in Cone Flowmeters

Disciplines: Chemical, Mechanical

Prerequisite skills: CHPR4406 – Transport Phenonena, CFD and FEA experience an advantage

Cone flowmeters are commonly used in flow measurement in the oil and gas industry, and are prone to Vortex Induced Vibration. These vibrations can cause the flow meter structures to break off, which can damage or obstruct downstream equipment. The objective of this

project will be to build transient CFD models of the cone flow meters to model and predict the frequencies of vortex shedding, providing a basis for developing design rules to guide their implementation.

Leggoe, Jeremy, Prof

Effect of Upstream Obstacles on Turbulence in Jets

Disciplines: Chemical, Mechanical

Prerequisite skills: CHPR4406 – Transport Phenonena, CFD and FEA experience an advantage

The break up of jets into droplets is heavily influenced by the turbulence generated by obstacles in the flow path upstream of the jet exit. This is commonly neglected in studies of jet break up, and the objective of this project will be to build on Craig Booth's work to develop scale resolving CFD models that will increase understanding of the effect of obstacles on jet behaviour.

Lehane, Barry, Prof

Axial capacity of driven piles in clay

Disciplines: Civil
Prerequisite skills:
The move to deeper water for offshore wind turbines has provided a renewed interest in improving design methods for evaluating the axial capacity of driven piles in clay. A project funded by a joint industry partnership (comprising 10 energy companies) has created a database of static load tests on piles in a wide variety of soils from around the world. The next phase of this project will be undertaken at UWA at the beginning of 2020 and will involve development of a new design method for inclusion in international codes. The three students assigned to this project will (i) assemble additional case history data from the literature to provide a check on the new method, (ii) perform statistical analyses of the new database for a variety of new formulations and (iii) be actively involved in a series new instrumented pile load tests in soft clay in East Perth.

Lehane, Barry, Prof

Optical measurement of strains in triaxial tests

Disciplines: Civil, Environmental, Mechanical, Mining, Software
Prerequisite skills:
This student(s) will conduct a series of triaxial experiments using a newly devised method for measuring strains in triaxial samples using low-cost cameras. Comparisons will be made with strains

measured in the conventional way and with numerical predictions of the strain distribution in a triaxial sample. It is hoped that the new system can replace existing soil testing practices around the world.

A software engineering student working on this project would devise and develop a front-end and back-end for the system.

Lei, Wen, Professor

Semiconductor Nanosensors

Disciplines: Chemical, Electrical & Electronic

Semiconductor nanostructures are semiconductor materials of nanoscale dimensions, including zero-, one-, and two-dimensional nanostructures. They have many unique properties such as large surface area-to-volume ratio, very high aspect ratio, and strong quantum confinement including both carrier and photon. This leads to many unique and desirable electronic and optical properties for semiconductor nanostructures and thus various novel devices with superior performance over existing devices to revolutionise our technological world. These nanodevices include transistors, light emitters, solar cells, and sensors that are used in our daily lives such as mobile phones, large-area displays, solar panels, and telecommunication systems. Apart from their super performance, these nanodevices present other advantages such as smaller size, lower cost, and higher energy efficiency, compared to traditional semiconductor devices with larger dimensions.

In this project, we will focus on the development of one- and/or two-dimensional semiconductor nanosensors with numerous potential applications ranging from light sensing, to environment sensing, and to telecommunication. This project can be divided into two main modules in which students choose both or either modules or any aspects of each module depending on interests of the students and duration of the program:

(1) Synthesis of high quality semiconductor nanostructures using CVD and/or MBE material growth tools, and understand, through various structural, electrical, and optical characterisation techniques, how to (i) improve the material quality, (ii) control the composition and material, and (iii) to engineer the bandstructure of nanostructures;

(2) Fabrication and characterisation of semiconductor nanosensors which involve (i) the design of the sensor structures, (ii) the use of state-of-the-art device fabrication facilities to make nanosensor devices, and (iii) characterising the performance and properties of the nanosensors to understand the underlying physics of the devices.

Through this project, the students will develop practical expertise and experience needed by semiconductor and other industries, including:

(1) Material synthesis/growth using CVD and/or MBE material growth facilities;

(2) Design and modeling of semiconductor devices;

(3) Material processing and device fabrication technologies within a cleanroom environment;

(4) Nanoscale material and device characterisation;

Required background:

Electronic and Electrical Engineering, Material Science, Physics, and Chemistry.

Lei, Wen, Professor

Scan Imaging Systems

Disciplines: Chemical, Electrical & Electronic

Imaging systems have been widely applied in various industry sectors as well as our daily lives. The imaging systems vary from the simple camera on our mobile phones to the complex large-scale infrared imaging systems used for night vision and satellite remote sensing. It is fascinating and challenging to understand how these imaging systems work and how to improve their system performance.

In this project, we will focus on building up a scan imaging system based on the infrared sensors fabricated at UWA, and utilizing this system to undertake infrared imaging in a laboratory environment. This project can be divided into three main modules in which students choose one or more modules depending on interests of the students and duration of the program:

(1) Undertake two-dimensional scanning of imaging sensors and understand how to improve the scanning efficiency;

(2) Synchronise the sensor scanning and other imaging set-ups in order to collect imaging data;

(3) Data and image processing.

Through this project, the students will develop practical expertise and experience needed by electronics, instrumentation and other industries, including Electronic Systems, Electronic Control Systems, Data and image processing.

The students will be advantaged if have knowledge and experience in microcontroller, and/or embedded system design and implementation, and/or Labview/Matlab programing, and/or other data/image converting and processing.

Required background:

Electronic and Electrical Engineering, Material Science, Physics, and Chemistry.

Lei, Wen, Professor

Noise control and reduction in working environment

Disciplines: Chemical, Electrical & Electronic, Mechanical

Working in noise environment for a long time can cause a series of health and environmental concerns. Therefore, it is essential to control and reduce the noise to a safe level. In this project, we will take a UWA engineering lab as a test vehicle to investigate various technical approaches to control and reduce the noise caused by the gas flowing, mechanical vibration, etc. Through this project, the students will develop practical expertise and experience in fluid dynamics, acoustic design, feedback

control, etc, which are widely needed by electronics, mechanics, instrumentation, acoustics and other industries.

The students will be advantaged if have knowledge and experience in fluid dynamics, and/or acoustic design.

Required background: Electronic and Electrical Engineering, Mechanics, Material Science, Physics and Chemistry.

Leong, Yee-Kwong, Prof

Evaluation of shear rate methods for yield stress fluids in concentric cylinder flow

Disciplines: Chemical, Environmental, Mechanical

Prerequisite skills: A good understanding of materials and mech. design

Mining companies in WA often characterized the flow behaviour of their yield stress suspensions using a concentric cylinder viscometer. With this measuring geometry, the shear rate is a function of the fluid model. There is no specific shear rate equation for yield stress fluid and so approximate method need to be found. Ideally the governing Couette flow equation should be solved inversely for the shear rate and such software program is not readily available. In this study, the shear rate will be calculated from experimental torque-rotational speed data using an approximate method and the accuracy will be compared to that obtained by solving the problem inversely for shear rate using experimental torque and rotational speed data for both concentric cylinder (including vane-cup system) and parallel plate measuring geometries. With parallel plate measuring geometry, the shear stress is a function of the fluid model.

Leong, Yee-Kwong, Prof

Upgrading iron ore quality in concentrated slurries – effect of water quality

Disciplines: Chemical, Environmental, Mechanical

Prerequisite skills: A good understanding of materials and mech. design

The concentration of iron ore feedstock for beneficiation should be as high as possible reduce water use especially in areas with low high quality water resource. This study will investigate the effect of water quality on iron ore beneficiation of concentrated slurries with and without UWA patented composite additives.

Leong, Yee-Kwong, Prof

Ageing behaviour of clay gels treated with additives

Disciplines: Chemical, Environmental, Mechanical

Prerequisite skills: A good understanding of materials and mech. design

Sepiolite, hectorite and bentonite gels displayed time dependent rheological or ageing behaviour at very low concentration of a few weight percent solids. The yield stress can reach several hundred Pa at these concentration. This behavior due to the interaction of van der Waals and electro double layer (EDL) repulsive forces. The EDL force was found to govern the microstructure development and hence is responsible for the time dependent behavior. This study will investigate the effect of additives on the time dependent behavior. The additives used may or may not moderate the EDL force.

Liu, Wei, Dr

Co-supervisor: French, Tim, Dr

Knowledge graph construction from uncertain and incomplete data

Disciplines: Electrical, Software

Prerequisite skills: Excellent programming skills (>80% CITS2200, CITS1401)

Knowledge graphs a machine readable representations of domain knowledge, specifying entities of interest, and the relationships between them. They differ from databases in that they encode the semantics (or meaning) of the data, allowing high level automated reasoning. This project will investigate the design and semi-automic generation of knowledge graphs from incomplete or unstructured data. Example data sets include synopses of sporting events, accident reports, or maintenance work orders.

Male, Sally, Associate Professor

Co-supervisors: Hassan, Ghulam Mubashar, Dr

Study of Students' Learning during Simulations

Disciplines: Electrical & Electronic, Mechanical

Prerequisite skills: Communication skills, Interest in VR would be useful

Students can develop attributes for engineering practice using VR and other simulations. This project will investigate the learning that occurs and the process that support the learning during a VR simulation used in classes.

Male, Sally, Associate Professor

Accountability of graduate engineers

Disciplines: Civil, Electrical & Electronic, Mechanical, Environmental, Mechanical, Mining

Prerequisite skills: Communication skills and critical thinking

Students can develop attributes for engineering practice using VR and other simulations. This project will investigate the learning that occurs and the process that support the learning during a VR simulation used in classes.

Male, Sally, Associate Professor

Record keeping by graduate engineers

Disciplines: Civil, Electrical & Electronic, Environmental, Mechanical, Mining, Software

Prerequisite skills: Communication skills and interest in engineering practice

Notebook keeping has been an important part of engineering practice. Electronic notebooks and other record-keeping practices are increasing. This project will explore the practices of graduate engineers.

Martyniuk, Mariusz, Professor

Investigation of mechanical properties of thin films via nanoindentation

Disciplines: Electrical & Electronic, Mechanical

Prerequisite skills: physics/engineering/materials science

This is a hands-on project involving a series of experimental instrumented nanoindentation runs on thin film samples. Data analysis and scientific reporting is a significant part of the project. The outcome of the project is to report the mechanical properties (Young's modulus, hardness, etc) of novel thin films deposited at the Western Australian Node of the Australian National Fabrication Facility. The

student should have a physics/engineering/materials science background, and potentially with specific prior knowledge/experience in instrumented nanoindentation.

May, Eric, Prof

Graham, Brendan, Dr; Rowland, Darren, Dr; Siahvashi, Arman, Dr

Avoiding Cryogenic Solids Formation in LNG Production

Disciplines: Chemical, Mechanical

Unplanned shutdowns of LNG plants caused by hydrocarbon solids blocking cryogenic heat exchangers are a major, ongoing problem for the industry. Current methods of avoiding them are costly and energy intensive. This project aims to produce the required new data and develop new predictive models relevant to natural gas processing and LNG production to help avoid unexpected shutdowns, improve plant efficiency, and increase safety.

May, Eric, Prof

Metaxas, Peter, Dr

Container-free hydrates: hydrate formation in acoustically levitated water droplets

Disciplines: Chemical, Mechanical

Gas hydrates are ice-like compounds consisting of water and gas molecules that can form within, and block, oil and gas flow lines. In this project, students will use Australia's first high-pressure acoustic levitation facility to study hydrate formation in water droplets that are suspended (via acoustic levitation) within a high pressure gas phase. This approach offers the unique possibility to study hydrate formation in container-less conditions. By removing the influence of the solid surface of a containment vessel (whose presence favours surface-dependent heterogeneous nucleation), the acoustic levitator enables an exciting opportunity to probe the fundamental processes governing hydrate formation in gas-water systems. This information will represent a critical contribution to a wider effort aimed at developing more economical, risk-based approaches to hydrate management and prevention which have significant potential benefits for the oil and gas industry.

May, Eric, Prof

Metaxas, Peter, Dr; Stanwix, Paul, Dr

A new microscopy-based tool for cryogenic solids detection

Disciplines: Chemical, Mechanical

Solids formed from heavy hydrocarbons and other natural impurities pose a major risk to reliable LNG production where they can freeze and block cryogenic heat exchangers at part-per-million (ppm) concentrations. New data on solids formation, especially at trace impurity concentration levels, will greatly aid in avoiding unexpected shutdowns, improving plant efficiency, and increasing safety. This particular project is focused on the use of a newly developed cryogenic microscopy apparatus which can be used to detect the nucleation of cryogenic solids from trace impurities in LNG under flow and/or shear. Direct visualization of crystal morphologies is also possible with the apparatus. The student will gain experience working with cryogenic, high pressure and vacuum systems, running equipment control and data acquisition systems and using state of the art microscopy tools, all while producing data with high relevance to the LNG industry. Beyond experimental work, there is also scope for the development of automated image analysis routines if of interest.

McDonald, Chris, Dr

Modelling Connected Autonomous Vehicles and Infrastructure

Disciplines: Electrical & Electronic, Software

Prerequisite skills: A passion for programming and problem solving; ideally some experience programming in C++ (or C and a willingness to learn).

Within 5 years years, the average consumer will be able to purchase an autonomous vehicle and drive it on our public roads, resulting in a dramatic change to traffic patterns and travel times. Beyond the benefits of autonomous vehicles are connected vehicles - vehicles that communicate their state, intention, and traffic conditions to other vehicles and to road-side infrastructure. The potential benefits of vehicle-to-infrastructure communication, particularly, are significant, including controlling vehicles through intersections - no more traffic lights - and using current and predicted road and congestion conditions to adjust the speed of vehicles.

Connected vehicle simulation needs to accurately simulate both the driving and route planning of vehicles, and the wireless communication in a very crowded environment. Current approaches separate these tasks by employing two different simulators, communicating through a common data format, but accuracy is lost when wishing to model 'real-time' wireless-based attacks against vehicles and infrastructure.

This project will first investigate the landscape of open-source vehicle simulators and then employ a chosen, or modified, simulator to model and investigate attacks against connect vehicles and infrastructure.

McDonald, Chris, Dr

Visualising Program Execution Traces

Disciplines: Electrical & Electronic, Software

Prerequisite skills: A passion for programming and problem solving; ideally some experience programming in C++ (or C and a willingness to learn).

As computer hardware becomes both faster and capacious, we can investigate previously too expensive techniques to support novice programmers. One such technique involves capturing the entire execution trace of a running program - its control flow and memory accesses - so that its execution may be reviewed. The program is not re-executed; instead its prior execution may be replayed, sped up, slowed down, and inspected. This provides great opportunity for novice programmers - they can watch the execution of a correct program, or determine which prior action resulted in a much later bug.

This project will investigate techniques for capturing and replaying program traces, with a view to improving the teaching of often difficult concepts such as dynamic-memory allocation and file input and output.

McFerran, John, Dr

Laser frequency control for an atomic-lattice clock using an Arduino Nano

Disciplines: Electrical & Electronic

Prerequisite skills: Some knowledge of electronic circuits

Optical-atomic-lattice clocks are the most accurate devices produced by humankind so far. Their accuracy is equivalent to a few seconds disparity over the age of the universe. The UWA lattice clock performance is progressing and aims to be part of an international network of atomic clocks to test aspects of fundamental physics. This student project relates to the control of a laser that probes the clock transition in ytterbium atoms. A digital synthesizer, which is communicated with via an Arduino Nano is used in the process. The student will test a custom made PCB to make the system clock-compatible (e.g. robust) and make improvements where necessary. It is part of the ARC's Centre of Excellence for Engineered Quantum Systems (EQuS) 2018-2024.

McFerran, John, Dr

Performance limits of a synchronous frequency-to-voltage converter

Disciplines: Electrical & Electronic

Prerequisite skills: Some knowledge of electronic circuits and circuit design software

This research group with a previous M. Eng. student demonstrated the successful application of a synchronous frequency-to-voltage converter (S-VFC) to laser frequency control (published work). In this project the student will explore the limits and capabilities of the S-VFC scheme further, hoping to extend the range of its application. A new circuit board will

be designed and tested that will involve some RF circuit techniques. The research applies to UWA's optical lattice clock in the Centre of Excellence for Engineered Quantum Systems.

Nener, Brett, Professor

Co-supervisors: Silva, Dilusha, Professor

Modeling of LASER based communication between an Optical Ground Station and a Satellite

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Mathematical and programming skills

Recent advances in satellite and laser technology have led to the possibility of high band-width and secure communication between a ground-station and a satellite. However, the limiting factor remains the optical impact of the intervening atmosphere. This project relates to modeling the transmission of optical signals through the atmosphere and in particular the effect of scintillation

Oldham, Carolyn, Prof

Co-supervisors: Ocampo, Carlos, Dr

Urban hydrology - exploring altered water and contaminant dynamics under urbanisation

Disciplines: Environmental, Civil, Mechanical

Prerequisite skills: These projects require students who are prepared to undertake field work, have experience in processing data and have good quantitative skill, are mindful of health and safety in the lab and field, are independent and critical thinkers, and are good communicators. Experience in GIS would be very useful.

Rapid urbanisation is occurring in many parts of the world, with potential impact on the security of water supplies and surrounding environments. To better manage urbanization and improve urban design, we must improve our understanding how land use change alters water and contaminant pathways. The complexity of these processes increases when groundwater is close to the surface, and intersects urban drainage and can impact urban infrastructure. There will be a range a projects around in this area of urban hydrology. There is scope in these projects for field work, hydrological sciences, numerical modelling, big data processing, GIS experience.

Orszaghova Jana Dr

Studying floating wave buoys for sensing and renewable energy

Disciplines: Civil, Mechanical
Prerequisite skills:

Are you interested in technology and development? Would you like to participate in the **Woodside FutureLab-funded RiverLab** working on innovative engineering solutions? These two RiverLab projects will investigate floating buoys interacting with waves.
The first project will analyse the suitability and performance of a very small scale buoy designed for measuring wave conditions. Low cost sensors are opening new opportunities for detailed studies of the ocean environment. Thorough testing of such devices are paramount before their deployment. Within this project the performance of the mini wave buoy will be examined in the state-of-the-art UWA wave flume and the Swan River.
The second project will study dynamics of a larger floating buoy designed to mimic a wave energy absorption device (ultimately to harness wave energy for electricity production). The buoy, together with its mooring system, has been optimised for the Swan River wave climate, such that it undergoes large heave (up-and-down) motion, which would ultimately result in part of the incident wave energy being absorbed. The surging and pitching motion also play a role, and will be investigated within this project, both numerically and experimentally. This project falls into a range of initiatives at UWA in the renewable wave energy area, which aim to accelerate the development of the offshore renewable energy sector, including wave energy and floating offshore wind.
Both projects will build upon previously successfully completed Riverlab projects. The Swan River will be utilised as a model wave basin, where field tests will be performed. Additional tests, in a more controlled environment, will be carried out in the UWA wave flume. All testing will be underpinned by theoretical and numerical analysis.
The project will require a team of **two students** working together on the following multi-disciplinary scopes:

☐ **Project 1: Suitability and performance of a small-scale wave buoy for measuring wave conditions**

The student will examine an in-house mini wave buoy instrumented with a 6 degree-of-freedom sensor for tracking its position and rotation in 3D. From these motion signals wave characteristics can be inferred. Detailed testing in the UWA wave flume and in the Swan River, with comparisons against other measurement techniques, will determine the suitability of our low cost wave buoy. Design alterations might be necessary to extend the performance of the mini buoy into the higher frequency range, and this will be examined within the project.

☐ **Project 2: Dynamics of a resonant floating oscillator and its mooring**

The student will analyse behaviour of a resonant oscillator system comprised of a floating buoy and a taut-mooring with a suitable restoring force, which has been optimised to match typical wave conditions in the Swan River. A theoretical model describing the heave, surge and pitch motions of the buoy will be developed. The student will carry out deployment and field monitoring of the system in the river. By varying the draft and the mass distribution within the buoy, the natural frequencies of the buoy can be varied, which will be investigated in the project, in order to maximise heave motion. The gathered motion and mooring load data will be analysed and compared to theoretical predictions.

Students are required to have **passed GENG5501 Coastal and Offshore Engineering** to be considered for the projects. Due to the nature of the project, successful students will be encouraged to complete a UWA snorkelling course so that they can participate fully in field tests.
Interested students are encouraged to contact Dr Jana Orszaghova (jana.orszaghova@uwa.edu.au), Dr Hugh Wolgamot (hugh.wolgamot@uwa.edu.au) and Dr Adi Kurniawan (adi.kurniawan@uwa.edu.au) for more information. More details about the Woodside FutureLab RiverLab program can be found here: http://www.oceans.uwa.edu.au/collaborations/woodside-futurelab/riverlab
Figure 1 Floating wave buoys for measuring waves (a) deployed standard wave buoy; (b) standard wave buoy; (c) the inside of the UWA mini wave buoy.
Figure 2 Previous Riverlab field tests in the Swan River (a) oscillating buoy; (b) measuring buoy motions and mooring loads; (c) suction caisson foundation.
Figure 3: UWA wave flume

Pan, Jie, Prof

Co-supervisors: Matthews, David, Dr; Hongmei Sun, Ms

Vibration transmission of a periodic pipe filled with water

Disciplines: Civil, Mechanical, Mining, Software

Prerequisite skills: This is a defence related project for Australian citizens only. Experience in MECH4426 on vibration measurement and modelling is preferred.

Many underwater structures can be approximated as periodic structures as they have equally-spaced bulkheads and frames. The vibration transmission from sources (engine and propeller) to other part of the ship structure is affected by the periodic properties. This project uses a pipe with periodically attached ribs as a model for investigating the effect of periodic configuration on the vibration transmission along the pipe. In particular, the effect of water inside of the pipe on the transmission properties will be examined for designing a quiet periodic structure.

Pan, Jie, Prof

Co-supervisors: Matthews, David, Dr; Jin Ming, Dr

Development of smart acoustical surfaces

Disciplines: Civil, Mechanical, Mining, Software

Prerequisite skills: This is a defence related project for Australian citizens only. Experience in MECH4426 on vibration measurement and modelling is preferred.

Practical use of underwater structures often requires their surface being sound absorptive and capable of detect the incoming and reflective sound. This project focuses the use of layered elastic material for effective sound absorption and embedded sensors for measuring the incoming and reflective sound. The outcome of the project will lead to the development of smart acoustical surfaces.

Pan, Jie, Prof

Co-supervisors: Bao, Chaoying, Dr; Sun, Hongmei, Ms

AI microphone array and its use for diagnosis of industry noise sources

Disciplines: Civil, Mechanical, Mining, Software

Prerequisite skills: Knowledge in signal processing and Matlab is required. Experience in MECH4426 on vibration measurement and modelling is preferred.

The objective of the project is to use the microphone array technology combining with machine learning techniques for condition monitoring of an array of similar equipment (e.g., conveyor belts, an array of ventilation or cooling fans, etc.) in an industry site.
The tasks in beamforming include (a) the comparative study of the robustness of different adaptive beamforming algorithms and (b) investigating and providing the guideline for setting up the parameter that regulates the robustness of adaptive beamforming algorithms. This research will be carried out through numerical simulation. Some knowledge in signal processing and Matlab is required.

Parish, Giacinta, Professor

Co-supervisors: Nener, Brett, Professor

Advanced Sensing Technologies: Transistor-based chemical sensors for contaminant monitoring

Disciplines: Chemical, Electrical & Electronic, Mechanical

Prerequisite skills:

Reliable, economically accessible technology for in situ monitoring of contaminants in water has the power to transform health, industry, and society the world around. Applications of such monitoring range from process control monitoring and optimisation for industry, to water supply quality and wastewater monitoring, to environmental monitoring for resource extraction, and beyond.

The microelectronics-based technology under investigation in this project will enable in situ, real-time contaminant monitoring that is accurate, reliable and low-cost. Semiconductor-based technology offers high performance and can also be mass produced at low-cost with flexible functionalisation allowing for a variety of analytes. Furthermore, it offers the ability to integrate multiple sensors into one chip, along with wireless communication technology for maximum benefit of the in situ monitoring capability.

Students will work together on the one or more of following integrated project components (and will also work alongside students working in the adjacent projects on “transistor-based biosensors”).

1. Physical, chemical, materials characterisation of functionalisation methods, particularly surface studies

2. Electrical, chemical and physical characterisation and optimisation of functionalised ion sensors

3. Mechanical, electrical and chemical characterisation and optimisation of packaging techniques

4. Design and integration of complementary sensors (pH, temperature, drift compensation) to maximise reliability.

5. Adapt device design, packaging, measurement protocols for reliable, reference electrode free, operation.

The ability to monitor biological and chemical signals with an electronic device is a tremendously innovative approach for cell research and process control in pharmaceutical and microbiological production, and chemical sensing applications. A bio-friendly, chemically inert and stable III-Nitride-transistor-based bio/chem-sensor will be developed to detect responses to various specific compounds/chemicals, particularly through cell receptors. The successful development of this electronic biosensor technology has the potential to improve health and disease treament through major improvemements in throughput, precision, quality, speed and simplicity of, for example, drug and disease testing methods.

Parish, Giacinta, Professor

Co-supervisors: Keating, Adrian, A/Prof

A new material for energy conversion; nanoporous

Disciplines: Chemical, Electrical & Electronic, Mechanical

Prerequisite skills: Minimum of one University-level chemistry unit

Hydrogen generation from sunlight is of great interest to address climate change and energy security concerns. Gallium nitride (GaN) is a material that has been commercially applied to light emitting diodes, lasers, and high power transistors, but also has the ideal energy band and chemical stability properties for

zero-bias hydrogen generation from solar energy applications and water splitting using sunlight (photoelectrolysis). Fabrication of nanoporous (NP) GaN allows for a tremendous increase in surface-to-volume allowing for much higher energy conversion efficiency of PEC reactions.

This project will assist in the development of a photoelectrochemical (PEC) etching process to fabricateNP-GaN from thin films, for future application to water splitting. The project is multi-faceted and you may work on aspects such as:

- Literature survey of published NP-GaN fabrication methods particularly for water splitting
- Consideration of safety aspects for undertaking PEC of GaN to create NP-GaN
- Adaptation of existing PEC equipment in our lab to fabricate NP-GaN OR building an entirely new PEC setup
- Implementing PEC of GaN to create NP-GaN
- Microscopy and optical measurement techniques to characterise the etched GaN.

Pham, Gia-Hung, Dr

Zhu, Mingming, Dr

Zhang, Dongke, Prof

Techno-Economic Analysis of Miniaturised Methanol/DME Production as H2 Carrier from Biomass Pyrolysis Syngas

Disciplines: Chemical, Mechanical

Methanol is an excellent hydrogen carrier. It can be easily manufactured from renewable resources, easily transported and stored in liquid form, and can be readily converted to hydrogen at the point of use or used directly as a clean and low-carbon transport fuel. Centre for Energy at The University of Western Australia and Anergy Pty Ltd., seeks to develop an innovative and miniaturised process technology for synthesising renewable methanol from biomass pyrolysis syngas and demonstrate the technology in a laboratory-scale pilot plant for engineering evaluation and process economic studies. With the development of robust catalysts and innovative reactors and the demonstration of the technology, the science base and technological foundation will be established, facilitating movement towards technology commercialisation. This project requires the students to 1) perform a literature review to collect performance information on relevant technologies for systems under evaluation; 2) Establish selection criteria and perform down-selection process to identify most appropriate scenario/s; 3) Design process models using Aspen Plus process engineering software; 4) Size and cost equipment based on literature references and experimental data and 5) Determine capital investments and perform discounted cash flow analysis. Two scenarios will be considered in the process simulation, namely centralised plant scenario and mobile modularised reactor scenario.

Sub- project1: Understanding the role of biochar on hydrogen and methane production

Our previous studies have found that adding biochar into two-phase anaerobic digestion process can enhance both hydrogen and methane production. Continuing the inquiry of this line, this sub-project is designed to understand the working mechanisms of biochar on both hydrogen and methane production from bench scale TPAD of food waste. The biochar will be leached to remove nutrients and the leached biochar will be added to bench scale H2 and CH4 production reactor. The gas volume and compositions will be measured daily using water displacement methods and GC, respectively. Volatile fatty acid (VFA) and pH as a function of time will also be monitored periodically. The microbes during anaerobic digestion process will be determined.

Sub-project 2: Commission and operation of a laboratory reactor to produce hydrogen and methane from food waste

The aim of the sub-project is to commission and evaluate the performance of a laboratory scale 5L reactors simulating TPAD process. The system consists of a hydrogen-producing reactor and a methane-producing reactor. The system will be commissioned to realise biogas production (H2 production in the first reactor and CH4 production in the second reactor). The gas volume and compositions will be measured daily using volumetric gas gauge and GC, respectively. Volatile fatty acid (VFA) and pH changing will also be monitored periodically.

Sub-project 3: Effect of biochar on the hydrogen sulfide (H2S) removal from biogas using bench scale and pilot scale biogas cleaning unit

The aim of the sub-project is to use biochar to remove H2S in biogas. The experiments will be conducted using bench scale column reactor. The gas composition will be measured using mass spectrometer and the efficiency of H2S removal will be calculated. The effect of type of biochar and addition ratio of biochar and gas retention time on H2S removal efficiency will be determined

Sub-project 4: Effect of biochar on ammonia (NH3) removal from biogas using bench scale and pilot scale biogas cleaning unit

The aim of the sub-project is to use biochar to remove NH3 in biogas. The experiments will be conducted using bench scale column reactor. The gas composition will be measured using mass spectrometer and the efficiency of NH3 removal will be calculated. The effect of type of biochar and addition ratio of biochar and gas retention time on NH3 removal efficiency will be determined.

Ravanbakhsh, Mehdi, Assoc Prof

Mian, Ajmal, Prof

Agriculture pest control through AI and snail detection

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Computer vision, python programming

Snail and slug are big issues in the grain industry in Western Australia and cost growers millions of dollars per annum to control. Currently, baiting is applied on a single rate on the entire farm which isn't efficient and harmful to the environment.

In this project, a deep learning solution will be developed to count snails and slugs on smartphone images captured during day and night. The result will be used to create a prescription map showing where and how much baiting needs to be applied.

Rayson, Matt, Dr.

Predicting underwater visibility in the Swan River

Disciplines: Biomedical, Chemical, Civil, Electrical & Electronic, Environmental, Mechanical, Mining, Software
Prerequisite skills: computer programming, swimmer (desirable)

Underwater visibility in marine environments limits the capacity of divers and remotely-operated vehicles (ROVs) to perform their desired functions, e.g., inspection of subsea infrastructure such as pipelines. Predicting the timing of low-visibility periods will enable project managers to plan ROV dives for suitable conditions and avoid costly down time. However, predicting visibility is an ongoing challenge due to the complex relationship with light propagation and other environmental conditions (e.g., turbidity, suspended material concentration and type). In this project, we will develop a novel underwater camera system to collect visibility data along with other water quality variables and build suitable mathematical models for prediction. This is an exciting, novel experiment where we will use the Swan River as a natural laboratory. Results will be directly applicable to offshore operators (e.g., Shell and Woodside) and their service providers. As the project is multi-disciplinary in nature (computing, instrumentation, design, modelling), we are seeking motivated students from all engineering majors.

Reynolds, Mark, A/Prof

Hassan, Ghulam, Dr

Exam Marking of Diagrams via Machine Learning

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Python (good), some knowledge of machine learning

Marking of exams is one of the tasks of lecturers and teachers that would be most useful to automate. There already exist systems that work well in managing online multi-choice quizzes or testing students programming expertise. There are also a few prototypes of systems using machine learning (ML) designed to read and grade hand-written essays and short text answers. In many disciplines, though, diagrams and formulas play an important part in exam answers.

This project aims to produce a prototype hand-written diagram marking system. The idea is to use ML to recognize parts of a diagram and reconstruct the diagram in a formal notation. The formal version of the diagram can then be graded using a rule-based system or another ML system. Actual graded student exam answers using diagrams will be available.

Reynolds, Mark, A/Prof

Hassan, Ghulam, Dr; Huynh, Du, Dr

Working with machine learning on very unbalanced image data sets

Disciplines: Electrical & Electronic, Civil, Software

Prerequisite skills: Good Programming (familiarity with Python)

Main Roads WA is interested with working with UWA on a range of computational modelling, visualisation, machine learning, AI and Data Science projects to do with traffic modelling, traffic monitoring and road maintenance.

Some of the topics to be tackled include:

This topic:

Working with machine learning on very unbalanced image data sets. These are images of roads in various conditions. The exact projects will be developed in consultation with Main Roads WA, the students and the supervisors.

Rowland, Darren, Dr

May, Eric, Prof

Thermodynamic calculator for oil and gas mixtures

Disciplines: Chemical, Mechanical, Software

Prerequisite skills: Experience with code development or programming languages

As part of an ongoing project, students will have the opportunity to contribute to the development of a user-friendly thermodynamic calculation tool that is currently in use by members of the oil and gas industry. Tasks may include: analysis of thermodynamic data; implementation of thermodynamic models; website development.

Rowland, Darren, Dr

Graham, Brendan, Dr

Deep ocean thermodynamics and climate change

Disciplines: Chemical, Mechanical

Students will contribute to an Australian Research Council Discovery Project, the principal aim of which is to obtain new insights into the thermodynamic and transport properties of seawater at high pressures that impact directly on our understanding of climate change processes. Tasks may include: collection of experimental data such as speed of sound or heat capacity; data analysis.

Rowshan Farzad, Pejman, Dr

Designing an interface for a programmable 3D motorized platform

Disciplines: Software

Prerequisite skills: Programming

The aim of this project is to create a robust GUI for a Zaber 3D Robotic platform. The 3D motorized platform is used to move the patient to correct position and compensate for internal organ motions during radiotherapy. The software code receives input data provided in different formats, opens and reads files and extracts important parameters such as amplitude, angle and time. The data conversion system converts these parameters into x, y and z coordinates which can be accessed and utilized by other systems. These commands will be passed to the communication system to interact with the hardware and cause hardware movements to the expected position.

Santoso, Jesse, Dr

Zhu, Mingming, Dr

Zhang, Zeno, Mr

Low-Temperature Plasma-Catalytic Conversion of CH4 and CO2 to Alcohols

Disciplines: Chemical, Mechanical

In order to better utilise the World's remote natural gas reserves, it is desirable to convert natural gas into liquids for more economic transport. Conventional thermochemical technologies for gas-to-liquid (GtL) conversion rely on large-scale centralised plants operating at very high temperatures and pressures which are not suitable for remote operations. One promising alternative approach is plasma-catalysis, which can be performed at a range of scales and under ambient conditions. In plasma-catalytic reactors, strong electric fields activate the reactants, creating highly reactive chemical species which are then guided towards desired products with the use of a catalyst. In this project, students will characterise the performance of a packed-bed plasma-catalytic reactor under various operating conditions for the conversion of CH4 and CO2 to Alcohols.

Sub-project 1: The effect of feedstock gas composition and reactor configuration on plasma break-down and characteristics

When an electric field reaches a certain threshold, it can cause gases to breakdown, forming a plasma. This process is similar to what occurs in lightning or a spark-plug, however the plasma reactor is designed to prevent the direct electrical arcs that are observed in those scenarios. The threshold at which breakdown occurs is highly sensitive to the gas composition, catalyst composition, electrode geometry, and reactor geometry. This then effects the efficiency and performance of the plasma reactor. The student will examine how the gas composition and reactor configurations affect the electrical properties, stability, and uniformity of the plasma discharge, and then relate this to the performance of the reactor for chemical conversion.

Sub-project 2: Characterising the performance of commercial catalysts in the plasma-catalytic reactor

Plasma-catalysis is a relatively novel and emerging field of research for chemical synthesis. It is not yet clear exactly how plasma-catalytic processes behave and how this might differ from conventional catalytic processes. It is therefore necessary to evaluate the performance of different types of common commercial alcohol synthesis catalysts in plasma-catalysis before we can begin to understand and develop specialised catalysts for plasma-catalytic reactors. The student will test the effect of a broad variety of commercial catalysts on the performance of the plasma-catalytic reactor for chemical conversion.

Sub-project 3: Steam reformation of methane in the plasma-catalytic reactor for two-stage gas-to-liquid conversion

As plasma discharges are highly reactive and indiscriminate environments, it may be difficult to directly produce alcohols in a plasma-catalytic reactor due to the fact that alcohols may be decomposed by the plasma itself. It may therefore be necessary to explore multi-stage approaches, where the plasma decomposition of the reactants is completely separated from the synthesis of the products. The most energy intensive step in conventional gas-to-liquid technologies is the steam reformation of methane (SRM) to produce H2 and CO (syngas) which can then be converted into the liquid fuels. This is the step which is most restricted to large-scale plants operating at high temperatures and pressure. If SRM can be performed with a plasma-catalytic reactor, this alone may be sufficient to enable GtL conversion at smaller scales. The student will help to construct a flow-controlled steam generator, characterise the effect of steam on the operation of the plasma system (including issues relating to condensation), and characterise the performance of the system for SRM in terms of overall conversion and power efficiency.

Sub-project 4: The effect of power supply parameters on performance of plasma-catalytic reactor

As the power is increased, there is typically a trade-off between the efficiency of a plasma reactor and the total conversion that is achieved in the reactor. The student will investigate this effect in the plasma-catalytic reactor and characterise how the reactor's performance changes with total input power (including considerations relating to heat generation). In addition to being able to control the total amount of power supplied to the system, a proposed method for improving the performance of the reactor is to rapidly switch the reactor on and off. This allows for higher instantaneous power to be achieved during the on period, and more favourable conditions for synthesis to be achieved during the off period. The student will also investigate the effect of switching frequency and duty cycle on the reactor performance.

Schediwy, Sascha, Dr

Synchronisation of the Square Kilometre Array

Disciplines: Electrical & Electronic

Prerequisite skills: Required: experience with analogue electronics and PCB design. Beneficial: experience with optical fibre systems, digital electronics

The aim of this project is to contribute to the development of the frequency synchronisation system for the Square Kilometre Array (SKA) radio telescope.

The SKA will be the largest and most complex astronomical instrument to date, with individual antennas spread over continental scales. One of the most complex technical challenges will be the coherent combination of astronomical signals collected by the hundreds of remote antennas. To achieve this, astronomical observations must be synchronised using timing signals of exquisite accuracy and precision. The SKA will utilise the same optical fibre network to transport the astronomical data to the SKA's central computer, to also distribute high-quality timing signals to each antenna.

The student will work as part of the Astrophotonics Group (www.icrar.org/astrophotonics) at the International Centre for Radio Astronomy Research (ICRAR) to help design, build, and test an optical fibre-based frequency distribution system tailored to meet the scientific needs and logistical challenges of the SKA. This system will be developed in our UWA laboratory, with the aim to conduct testing with in South Africa, and at the Dominion Radio Astrophysical Observatory in Canada.

Please contact Dr Sascha Schediwy before selecting this project to confirm that you meet the prerequisites.

Schediwy, Sascha, Dr

Building a car sunroof-mounted laser turret

Disciplines: Mechanical

Prerequisite skills: Required: experience working with mechanical hardware, welding. Beneficial: mechanical CAD, electronic motors and control systems

The aim of this project is to further the development of ultra-precise laser timing links to support the next-generation of pioneering space missions and cutting-edge timing technology.

The phase-stabilised transfer of optical-frequency signals over free-space laser links, particularly between ground stations and satellites, will revolutionise fields ranging from high-speed space-to-ground optical communications and geodesy with optical Doppler orbitography, to tests of General Relativity and fundamental physics.

The student will work as part of the Astrophotonics Group (www.icrar.org/astrophotonics) at the International Centre for Radio Astronomy Research (ICRAR) to help design, build, and test a mechanical structure to enable a laser mount be raised through a car sunroof. The front

passenger seat will be removed and the mechanical structure will need to be attached to seat mounting points. The structure will need to be able to be raised and lowered while the car is moving, either using motors or manually by the laser operator in the back seat.

This work will be conducted in collaboration with the French national Space Agency CNES, and the Sytèmes de Référence Temps Espace at Paris Observatory.

Please contact Dr Sascha Schediwy before selecting this project to confirm that you meet the prerequisites.

Schediwy, Sascha, Dr

Automatic alignment and tracking of laser link mounts

Disciplines: Electrical & Electronic

Prerequisite skills: Required: Experience working with serial comms; Digital and Embedded Systems (ELEC4403). Beneficial: Experience with programming in Python and Java

The aim of this project is to further the development of ultra-precise laser timing links to support the next-generation of pioneering space missions and cutting-edge timing technology.

The phase-stabilised transfer of optical-frequency signals over free-space laser links, particularly between ground stations and satellites, will revolutionise fields ranging from high-speed space-to-ground optical communications and geodesy with optical Doppler orbitography, to tests of General Relativity and fundamental physics.

The student will work as part of the Astrophotonics Group (www.icrar.org/astrophotonics) at the International Centre for Radio Astronomy Research (ICRAR) to help design, build, and test an automatic alignment and tracking system for two commercial-grade optical telescope mounts (SkyWatcher EQ6 and EQ8). The mounts will need to communicate their GPS-obtained positions to each other via mobile network, steer towards each other for a rough alignment, then achieve final alignment and live tracking using machine vision of a beacon laser detected with a camera, and/or using a quad-photodetector.

Alternatively, the student could work with our Red Pitaya field-programmable gate array (FPGA) hardware to supersede some of our group's older test equipment. This work could include programing the Red Pitayas as PID controllers, phasemeters, and frequency counters, and then testing their performance compared to more expensive dedicated commercial products.

This work will be conducted in collaboration with the French national Space Agency CNES, and the Sytèmes de Référence Temps Espace at Paris Observatory.

Sercombe, Tim, Prof

Metal 3D Printing using Elemental Powder

Disciplines: Chemical, Mechanical

Metal 3D printing of alloys is usually performed through the use of pre-alloyed powder. This is where each powder particle contains the correct chemical composition. However, this is much more expensive than using elemental blends of powder and then using the printing process to produce the alloy. This project will investigate the viability of producing parts from elemental mixed powder. This will include determining the density, microstructure, homogeneity and mechanical properties of the printed parts

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Sercombe, Tim, Prof

Design of Activities for student visits.

Disciplines: ALL

The aim of this project is to design and build (or have built) activities that can be used to encourage student to keep engaged in STEM during high school and beyond. Working with myself and the Girls in Engineering team, you will be required to come up with various concepts for activities, prototype them, select the most promising and oversee the construction and final testing of the best one. This will be used during Girls in Engineering events, during school visits to UWA, open day etc. Ideally the activity should also be able to be easily tailored such that it is appropriate for different year levels.

Sercombe, Tim, Prof

Kop, Alan Adj A Prof (Royal Perth Hospital)

Poly Caprolactone Scaffolds functionalized with calcium phosphate for bone tissue engineering applications.

Disciplines: Biomedical, Mechanical

The work will be predominantly carried out at Royal Perth Hospital in the Dept. of Medical Engineering and Physics.

This project builds on the work done by a Masters student in 2018/2019. We are looking to optimise the use our melt extrusion Allevi 3D printer to print simple and complex shapes of a composite material comprising PCL and calcium phosphate for potential bone tissue engineering applications. During 2018/2019, the Allevi printer was commissioned, however it was not able to be fully tested or optimised. In addition a Noztek extruder to produce filament for an alternative FDM printer had limited success. With successful extrusion, the

aim is to compare the print capabilities of our FDM printer vs the melt extrusion printer with a specific aim of producing a scaffold suitable for bone tissue engineering.

Silva, Dilusha, Professor

Co-supervisors: Putrino, Gino, Associate Professor;

Advanced Sensing Technologies: Sensing in liquids

Disciplines: Chemical, Electrical & Electronic, Mechanical, Software

Prerequisite skills: Electronics design experience; programming in Python, analysis of basic optical systems with lenses.

Researchers within AST are the leaders in Australia for micro machines (MEMS). One of their recent inventions is an ultrasensitive MEMS based chemical and biological sensor.

The technology operates on a tiny cantilever that produces a tiny movement in response to a chemical or biological agent it comes in contact with. At present, the key application of this technology is in gas sensing, and has already demonstrated sensitivities better than parts-per-million. However there are immense applications of this technology, if it could be used in a liquid environment. The broad objective of this project is to deploy and demonstrate this technology in various liquid environments.

Silva, Dilusha, Professor

Co-supervisors: Putrino, Gino, Associate Professor;

Advanced Sensing Technologies: Absorption spectroscopy for organics in solution

Disciplines: Chemical, Electrical & Electronic, Mechanical, Software

Prerequisite skills: An understanding of the properties of light (first-year physics); electronics design experience; programming in Python.

Absorption spectroscopy can determine chemical components of a material by measurement of which wavelengths of light are absorbed due to interaction with a sample. Applications of this technology range from determining hydrocarbon contamination in water to detecting cancer in skin.

This project will evaluate the ability of infrared (IR) spectroscopy to measure the chemical composition of aqueous solutions. Trials with solutions containing a matrix of varying and interfering IR-absorbing components will be performed for applications in environmental and agricultural monitoring.

Techniques to improve the component prediction accuracy using techniques such as principle component analysis will be investigated.

Silva, Dilusha, Professor

Co-supervisors: Putrino, Gino, Associate Professor;

Advanced Sensing Technologies: Nanotechnology Spectrometers

Disciplines: Chemical, Electrical & Electronic, Mechanical, Software

Prerequisite skills: Programing in Python and Matlab; a basic understanding of the properties of light (first year physics).

Infrared spectroscopy is finding increasing application in many industries including, pharmaceuticals, agriculture, viticulture, remote sensing, and defence. IR spectroscopy has successfully been demonstrated to detect a range of substances, including water, nitrogen and carbon in soil, protein in wheat, and pollution in the atmosphere.

Deployments of spectroscopy range from lab-based instruments for high-precision applications, to semi-miniaturised instruments for portable applications, to multi- and hyper-spectral imaging instruments for airborne remote-sensing applications. In the airborne arena, unmanned aerial vehicle (UAV) based deployments are looking increasingly attractive. The main limiting factors to more pervasive deployment of infrared spectroscopy are presently, the capital and maintenance costs of the spectroscopy equipment; size and portability; sensitivity to vibration and shocks; and calibration maintenance. Particularly for application in Agriculture and the minerals industry, the need for low cost, small and rugged spectroscopy instruments is immense.

Researchers within AST are the leaders in Australia for micro machines (MEMS). One of their recent developments is a suite of nanometer-scale thin-film spectrometer technologies, which stands to address all the requirements to turn infrared spectroscopy into an everyday tool. Just imagine a spectrometer in your mobile phone that can tell you if your fruit is ripe enough or your milk is turning sour. The overall aim of this project will be to assess and develop thin-film spectrometer technologies for various applications. While these projects are highly challenging they can be immensely rewarding.

Silva, Dilusha, Professor

Co-supervisors: Putrino, Gino, Associate Professor

Advanced Sensing Technologies: Multispectral Camera

Disciplines: Electrical & Electronic, Mechanical, Software

Prerequisite skills: Programming in Python, some electronics integration experience

Infrared spectroscopy is finding increasing application in many industries including, pharmaceuticals, agriculture, viticulture, remote sensing, and defence. IR spectroscopy has successfully been demonstrated to detect a range of substances, including water, nitrogen and carbon in soil, protein in wheat, and pollution in the atmosphere.

Deployments of spectroscopy range from lab-based instruments for high-precision applications, to semi-miniaturised instruments for portable applications, to multi- and hyper-spectral imaging instruments for airborne remote-sensing applications. In the airborne arena, unmanned aerial vehicle (UAV) based deployments are looking increasingly attractive. The main limiting factors to more pervasive deployment of infrared spectroscopy are presently, the capital and maintenance costs of the spectroscopy equipment; size and portability; sensitivity to vibration and shocks; and calibration maintenance. Particularly for application in Agriculture and the minerals industry, the need for low cost, small and rugged spectroscopy instruments is immense.

This project will focus on developing a low cost spectral imaging camera for agricultural applications. The project will involve assembling the camera module to a Raspberry Pi single-board computer, incorporating the spectral selectivity elements, and developing the software to acquire and process spectral images.

Sreeram, Victor, Professor

Co-supervisors: Ahmed, Razin

Design a smart forecasting model for solar power generation

Disciplines: Electrical & Electronic

Prerequisite skills:Matlab

The majority of electric power generation in most countries still relies on non-renewable pollution-causing fossil fuels as the primary energy source. The combustion of fossil fuels for energy has led to global warming and other associated environmental catastrophes. Over the past two decades, the field of solar energy harnessing technology has experienced remarkable growth. However, it is highly susceptible to atmospheric conditions and climate, hence precise prediction of solar power generation is the challenge facing the researcher at the moment. Among various techniques, machine learning (AI) method is very well known, and deep learning or deep neural network has transcended due to its capability to learn from voluminous input information. It uses an improved learning algorithm, better parameter analysing methods and a vast number of hidden layers. There are mainly four types of deep learning, a restricted Boltzmann machine (RBM), deep belief network (DBN), autoencoder (AE) and deep convolutional neural network (DCNN). This research work will extensively study each of the four deep learning methods, their characteristics and their extensions to build a smart forecasting model for solar power generation.

Sreeram, Victor, Professor

Design of digital control systems

Disciplines: Chemical, Electrical & Electronic, Mechanical

Prerequisite skills: Matlab

Many of today's control systems use digital computers to provide compensation to a continuous time plant or a process. A control engineer must design compensations for such digital systems and these compensators are realized using a set of difference equations programmed into the computer. Design techniques for digital systems parallel those developed for continuous systems (GENG4402). In this project, we study and compare the performance of several methods for designing digital compensators which include: 1. Conversion of a classically designed continuous compensator into an equivalent digital compensator. 2. Direct design of a digital compensator using frequency transform techniques. 3. Direct design of a digital compensator using state-space techniques. A good knowledge of GENG4402 is essential.

Sreeram, Victor, Professor

Co-supervisors: Zulfiqar, Umair

Mathematical modelling of power systems

Disciplines: Electrical & Electronic

Prerequisite skills: Matlab

In today's technological world, physical systems or processes are described mainly using mathematical models to describe the behaviour of the underlying processes. A physical system may be a chemical process, a multimachine electrical power system, an attitude-control system of a space craft, a synchronous orbit satellite, a flexible space structure, very large scale integrated (VLSI) circuit, a power system, etc. Deriving a reasonable

mathematical model is fundamental to the analysis and design of a dynamic system. In practice, one can obtain a fairly complex or nonlinear and a very high order model for the system (or plant). This complexity often makes it difficult to obtain a good understanding of the behaviour of the system. The analysis and design of such systems can be

accomplished with greater ease if a linear low-order model is derived which provides a good approximation. In this project, our objective is to obtain a linear lower order model for a large multi-machine electric power system from the nonlinear differential equations governing the system.

Stanwix, Paul, Dr

New Methods for Analysing the Structure of Human Skin

Disciplines: Chemical, Electrical & Electronic, Mechanical, Software

Prerequisite skills: Whilst there are no prerequisite skills, an enquiring mind and willingness to learn about new topics, running experiments, analysing data, and simple programming is beneficial.

Whilst clinical scanners have revolutionised patient outcomes with high-resolution imaging, there are many skin conditions for which it is either too expensive or doesn't provide the required sensitivity.

Since skin disorders are often confined to a small region extending only a few millimetres below the surface, there is the potential to develop novel tools for skin diagnostics based on compact and low cost measurement technology. This project aims to apply compact Magnetic Resonance Imaging (MRI) Dielectric Relaxation Spectroscopy techniques to the analysis of skin structure and composition.

Please contact me if you would like to learn more about the project and how you can be involved.

Stanwix, Paul, Dr

Signal enhancement for low-field NMR sensing

Disciplines: Chemical, Electrical & Electronic, Environmental, Mechanical, Software

Prerequisite skills: Whilst there are no prerequisite skills, an enquiring mind and willingness to learn about new topics, running experiments, analysing data, and simple programming is beneficial.

Low-field nuclear magnetic resonance (LFNMR) is an attractive technique for the development of sensors to monitor environmental and chemical engineering processes as it is cheap, compact, and portable. It suffers, however, from the small signal associated with operating at low magnetic field. This project will implement strategies to improve the signal to noise of LFNMR through signal enhancement techniques and control systems to reduce sensitivity to environmental variations. The intended application will the development of a signal enhancement module for multi-phase flow metering. Students will be involved in developing hardware, performing experiments and optimising analysis of the results. Please contact me if you would like to learn more about the project and how you can be involved.

Stanwix, Paul, Dr

Diamond sensors for investigating chemical processes

Disciplines: Chemical, Electrical & Electronic, Environmental, Mechanical, Software

Prerequisite skills: Whilst there are no prerequisite skills, an enquiring mind and willingness to learn about new topics, running experiments, analysing data, and simple programming is beneficial.

This project will explore the application of diamond based sensors to the study of processes that occur at the micro-scale, for example hydrate formation or gas adsorption in in porous media. Our understanding of and ability to model these processes would be greatly improved by the ability to perform direct measurements of pressure and temperature inside the pores, which requires sensors with resolution below 100 nm. Diamond is a promising platform for development of such a sensor as it is sensitive to a wide range of parameters, even at the nano-scale, and can withstand harsh environments. Students on this project may be involved in the development of laser-based experiments to probe diamond material, software development, and data analysis. Please contact me if you would like to learn more about the project and how you can be involved.

Stanwix, Paul, Dr

May, Eric, Prof

Microwave Cavities for Phase Behaviour Sensing

Disciplines: Chemical, Mechanical

Accurate knowledge of the phase behavior of fluid mixtures is crucial for the design and operation of gas processing and transport systems. This project aims to develop innovative fluid sensing technology using high-precision microwave cavities, which will be capable of accurately investigating the behavior of fluid mixtures near their phase boundaries. This technology will be used to generate reference-quality data, necessary for development and validation of equations-of-state, and to understand the underlying mechanisms involved in phase transitions. Students working on this project will contribute to the design and modelling of microwave cavities, measurement of fluid mixture phase boundaries and phase fractions, and development of automated measurement and data analysis systems.

Stanwix, Paul, Dr

May, Eric, Prof; Al Ghafri, Saif, Dr

Measuring sound speed in low Global Warming Potential refrigerants

Disciplines: Chemical, Mechanical

The growing need for low Global Warming Potential (GWP) refrigerants has motivated the study of numerous 4th-generation refrigerants for which there is a dearth of thermophysical data. This project will involve measuring the speed of sound in low GWP refrigerants using a

recently constructed ultra-sonic pulse-echo experiment, developing analysis tools, and deriving further properties such as density and specific heat capacity.

Staveley-Smith, Lister, Prof

Optimizing the efficiency of the FAST radio telescope

Disciplines: Electrical & Electronic

Prerequisite skills: Project will involve ray tracing, wave propagation, antenna design. Some computing/software experience is needed.

The Five-hundred-meter Aperture Spherical Telescope (FAST) in Guizhou province, China is the largest radio telescope in the world. It is currently undergoing science verification by a team which includes students and researchers at UWA. An area of concern is the frequency response of the telescope, which introduced 'ripples' into the power spectra of faint astronomical sources. This project will look at ways of tuning the active surface of the antenna to reduce this problem.

Sunderland, Andrew, Dr

Airborne Electromagnetic Exploration

Disciplines: Civil, Electrical & Electronic, Mechanical

Prerequisite skills:

Electromagnetic systems flying 100 metres above the ground are used for mineral and water exploration. We are looking for a mechanical engineering student to help develop a new suspension system and increase the sensitivity at low frequencies. A second electrical engineering student would help design new transmitter and receiver electronics to increase sensitivity at high frequencies.

Thompson, Sally, Assoc/Prof

Disturbance impacts on groundwater recharge in the Perth Basin

Disciplines: Civil, Environmental
Prerequisite skills:

Groundwater supplies the majority of drinking water to Perth, and its importance for our water supply is growing. Sustainable use of groundwater requires understanding how it is replenished by the process of

recharge. By using a uniquely detailed dataset from the Gingin TERN Fluxtower site, students in this project will explore how disturbances such as fire impact recharge. Specific projects related to this topic could include data analysis from the tower, or GIS-based analyses that focus on understanding how future fire disturbance regimes (or prescribed burning) might influence Perth's water supply security.

Thompson, Sally, Assoc/Prof

Can we measure how drought-stressed trees are from how much their canopies weigh?

Disciplines: Civil, Environmental, Mechanical
Prerequisite skills:
Did you know that you can measure how heavy a tree's canopy is - including the extra weight that it gains when rain is caught (intercepted) in that canopy? We're in the process of building sensors to do just that, but we have another question — could these same sensors help us understand how stressed out trees are becoming during droughts? To answer this, we want students to run an experiment where we measure how much leaf mass changes as leaves dry out. Using simple equipment (a pressure chamber, that measures how drought stressed leaves are, and a scale - to measure mass) we're looking for students to design and implement an experiment that will enable us to understand if leaf masses change enough (as they dry) for us to be able to detect it at the scale of a whole canopy.

Thompson, Sally, Assoc/Prof

FUNDED PROJECT - The dynamic demography of water ages used by threatened trees

Disciplines: Environmental
Prerequisite skills: Familiarity with statistical methods and/or numerical modelling, basic chemistry, and/or environmental monitoring would be advantageous.

How old are the waters our threatened plants use and how variable is this distribution of ages? This is a key question, often the impetus for water balance studies. When plants transpire, that water may have fallen as rain the day before (young), weeks ago (juvenile), months ago (middle aged) or last year (old, in the context of water isotopologues). This project is concerned with quantifying the dynamics of the age distribution of water used by plants, as this offers the potential for new insights into ecophysiological strategies to cope with water and salinity stress. The aim of this honours/masters project is to conduct a proof of concept experiment to demonstrate the proposed method to ascertain the dynamic age distribution of water used by a plant for the first time. A numerical modelling approach already implemented in R/matlab will be used to interpret measurements.

The project will provide the student with interdisciplinary training spanning environmental sampling, ecophysiology, and numerical modelling. The student will receive additional support from mentors in scientific methods, data analysis, scientific writing and public speaking.

The project is funded to a level of $15,000.

Interested candidates must contact Sally Thompson for a consultation. Please bring a CV, academic transcript and brief cover letter explaining interest in the project with you.

A shortlist of candidates (and their materials) will be provided to DBCA who will make the final selection for the project.

Thompson, Sally, Assoc/Prof

Putting structural and environmental engineering together to measure canopy water dynamics

Disciplines: Civil, Environmental, Electrical & Electronic, Mechanical
Prerequisite skills:
Trees intercept rain in their canopies - how much rain gets trapped here is a major uncertainty in understanding the hydrologic cycle. We are testing instruments known as interceptometers to measure how much water is in the canopy based on how much stems compress and extend. Students involved in this project can:

- use the interceptometers to measure the modulus of elasticity of tree species

- modify the design of the interceptometer to make it easier to install in the field

- test the effects of temperature variations on the performance of the instrument

- assist us in installing and calibrating the instrument in the field.

- (Electrical engineering only) assist in the design and programming of loggers for these sensors.

Togneri, Roberto, Professor

Are you up to the challenge?

Disciplines: Electrical & Electronic, software

Prerequisite skills: MATLAB/Python, signal processing

Solving real problems in sensing and analysis requires a large investment in hardware and time to acquire the data. One solution is to use simulations, another is sponsored challenges where the investment is made to provide real-world recordings of data for research. And this is what this project is about! As a team of up to 3 students you can choose to go through any of the following challenges in audio and speech for detection, enhancement, and recognition: Signal Processing Cup

https://signalprocessingsociety.org/get-involved/signal-processing-cup ; SiSEC (Signal Separation Evaluation Campaign), https://sisec.inria.fr/ ; DCASE (Detection and Classification of Acoustic Scenes and Events) http://dcase.community/ ; (ASVspoof) Speaker Spoofing https://www.asvspoof.org/ ; and Physionet (clinically interesting problems) https://physionet.org/about/challenge /. Choose the challenge that interests you and check that data and, ideally, software tools are available and who knows? Maybe we can enter to be the winning team (e.g. Signal Processing Cup)!

Togneri, Roberto, Professor
Co-supervisors:

Deep learning for clinical diagnosis of voice

Disciplines: Biomedical, Electrical & Electronic

Prerequisite skills: MATLAB/Python, Signal Processing

Deep neural networks have been applied to a wide range of applications for detection of events and recognition of objects for complex signals and images. One of the burning issues is the black box approach which limits understanding of what the deep network is learning, especially important for diagnostics. The need for interpretability of the deep network is now apparent. In this project you will investigate how attention can be used to determine which features are important in the final diagnosis, and relate these features to physical or physiological attributes as the main contributing factors. This idea has only just been applied to clinical diagnosis (see https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6373907/). For this project you will work with a PhD research student on the voice features which contribute to speech driven conditions (esp. autistic behavior). Other reading to get you started: https://towardsdatascience.com/recognizing-speech-commands-using-recurrent-neural-networks-with-attention-c2b2ba17c837

Townsend, Chris, Dr

Power Electronics for Battery Energy Storage Systems

Disciplines: Electrical & Electronic

Prerequisite skills: Power Electronics

Battery Energy Storage Systems (BESS) will play a critical role in compensating the intermittency of renewable power injected into West Australian power grids. Knowledge of the functionality and performance of the power electronic interface, that sits between the batteries and the grid, will be key to various stakeholders in the grid's operation, such as Western Power, Synergy, Horizon Power and renewable/non-renewable generators. This project will develop a modular next-generation power electronic interface capable of being scaled for deployment in household applications up to multi-megawatt grid-support applications.

van Heijningen, Joris, Dr

New vibration isolation techniques for gravitational wave detectors

Disciplines: Chemical, Materials, Mechanical, Mechatronic

Prerequisite skills: ANSYS/ COMSOL (preferable), Mathematica/ Matlab, some knowledge of vibration isolation, experimental skills

This project is to design and test a novel new concept of low frequency vibration isolation system using Euler springs. The Euler springs have been used in UWA's Gingin High Power Optical Test Facility (HOPTF) to vertically isolate cavity mirrors from the Earth's ever-present motion. New developments on Euler springs will improve the current isolation performance. Students would analyse the springs in finite element models, fabricate the actual springs and perform experiments showing the improved performance.

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van Heijningen, Joris, Dr

Distributed control and data acquisition system

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Matlab SIMULINK (preferable), programming skills

This project is to implement advance digital control system for the UWA's Gingin High Power Optical Test Facility (HOPTF). The project needs enthusiastic students with programming skills to set up the distributed Control & Data System (CDS) and use the control system to tame an 80 meter long optical cavity.

Wen, Linqing, Prof

GPU-CUDA Code Optimization for Speed

Disciplines: Software

Prerequisite skills: Proficient in C/python/CUDA programming and Linux OS

Optimization of the GPU acceleration used in the on-line searches of gravitational waves. It involves profiling the search pipelines to find bottle necks, optimization and test.

Wen, Linqing, Prof

Optimization of Data Whitening

Disciplines: Software

Prerequisite skills: Signal processing, FIR/IIR filters, proficient in C/python programming skill

Test and optimize low-latency data whitening technique instead of using Fourier Transform.

Wen, Linqing, Prof

Machine Learning for Gravitational Wave Detection

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Proficient in C/python programming skill, Linux OS and signal processing.

Apply machine learning technique to detect, localize, and classify gravitational wave events in detector data.

Wen, Zeyi, Dr

Mian, Ajmal, Professor

Building robust machine learning models

Disciplines: Electrical & Electronic, Software

Prerequisite skills: Basic knowledge in machine learning; good programming skills

A small change in the training data may lead to a big change for machine learning models. This is also known as model vulnerability to adversarial attacks. Model robustness is a key consideration for machine learning techniques to be deployed in production. In this project, students will conduct research on building robust machine learning models. Two key tasks in this project are: (i) building models with robust features; (ii) selecting machine learning algorithms for robust models. Interesting case studies can be added to the tasks based on the students' previous experience.

Wicenec, Andreas, Prof

Reinforcement learning agent for a dynamic data-processing scheduler

Disciplines: Software

Prerequisite skills: Python programming, Git (optional), Machine Learning (desirable)

The data challenges presented by Square Kilometre Array (SKA) necessitate changes in how observation data-products are processed. The size of SKA-scale data products restricts the amount of raw observation data that can be kept 'on-hand'; data storage facilities (the 'buffer') will overrun within 2-3 weeks of observations if the data is not reduced. This means the data-processing has a direct effect on the telescopes capacity to observe - and, therefore, potentially limits the science output. Currently, we are actively developing TopSim, a telescope operations simulator designed to test various scheduling and planning techniques for this data processing. Existing research suggests that scheduling with respect to tasks and resources alone is not enough to produce the most effective schedule (Barrett et. al 2011, Mao et al. 2019); additional information about the environment in which tasks are being scheduled (in this case, the status of observations, delays in the schedule, and the data in the buffer) should be used to improve the accuracy of scheduling decisions. This project involves the investigation and development of a reinforcement learning-based scheduling agent that interfaces with the TopSim simulation environment. The agent will likely take inspiration from the RL-Agent used in CloudSimpy, from which TopSim is derived. It is anticipated the project will involve the use of the PyTorch deep-learning library.

Winterflood, John, Dr

Real-time data acquisition using Mathematica

Disciplines: Electrical & Electronic, Mechanical, Software

Prerequisite skills: Programming in Mathematica

The task is to migrate an existing real-time data acquisition system. Please email John Winterflood or Frank van Kann for more details.

Wittek, Adam, Prof

Towards Biomechanical Criteria for Assessment of Rupture Risk of Abdominal Aortic Aneurysm (AAA)

Disciplines: Biomedical, Mechanical

Prerequisite skills: Good knowledge of solid mechanics and willingness to acquire new knowledge in medical image analysis

Abdominal aortic aneurysm (AAA) is a permanent and irreversible dilation of the lower region of the aorta. If untreated, it can result in rupture of the aorta. AAA rupture is a catastrophic event with mortality rates of higher than 80%. Currently, the most widely-used evidence-based indicator of rupture threat is the maximum anterior-posterior or transverse diameter: diameters greater than 5.5cm. However, 20% of AAAs with smaller diameter rupture, while larger AAAs often remain quiescent. The ability to predict, non-invasively, which AAA cases are at risk of rupture will have a major clinical impact by saving lives and reducing medical costs worldwide.

This project is a part of larger research effort that aims at addressing this challenge through formulation of biomechanics-based AAA rupture risk criterion that relies on information about stress in the AAA wall (predicted using finite element analysis) and strain in the AAA wall during the cardiac cycle (determined from the AAA medical images).

Wittek, Adam, Prof

Towards Realistic Surgical Simulation: Meshless Algorithms of Computational Biomechanics for Predicting Organ (Brain) Deformations Due To Surgery — Evaluation and Performance Optimisation

Disciplines: Biomedical, Mechanical, Software

Prerequisite skills: Good knowledge of solid mechanics or numerical analysis/computer programming (or both).

Surgical tool placement/insertion in the body organs (such as e.g. needle insertion when

conducting biopsy or localising seizure onset zones for epilepsy treatment) is a challenging task that requires to account for changes in the surgical target position caused by organ deformation due to interactions between a surgical tool and the tissue. One may attempt to track a surgical target (e.g. tumour) and tool using medical imaging. However, intraoperative 3D imaging (magnetic resonance imaging MRI, computed tomography, ultrasound US) for surgical tracking is limited using the equipment in standard operating theatres. Predicting the intraoperative organ/tissue deformations using the methods of computational biomechanics can augment the currently used imaging techniques for surgical tracking. Possible applications include computer integrated surgery (CIS) systems and control systems for surgical robots.

This project focuses on evaluation and improving computational efficiency of meshless algorithms of computational biomechanics (that use computational grids in a form of a "cloud" of points) for predicting deformations within the brain undergoing surgery and forces acting on surgical tools.

This will involve parametric studies for different numerical parameters and different surgical scenarios and evaluation against the results obtained using well-established algorithms of computational mechanics available in industrially applied simulation/CAE codes and previously conducted (in cooperation between UWA Intelligent Systems for Medicine Laboratory ISML and Surgical Assist Technology Group from AIST in Tsukuba, Japan) experiments using swine brain specimens and experiments using the mechanical brain phantom (made from silicone gel) constructed at ISML.

Wittek, Adam, Prof

Meshless Algorithms of Computational Biomechanics for Surgical Simulation: Pre- and Post-Processors for Creating Computational Biomechanics Models and Visualisation of Results

Disciplines: Biomedical, Civil, Mechanical, Software

Prerequisite skills: Prior experience in computer programming

Meshless algorithms of computational biomechanics, that utilise computational grids in a form of clouds of points, have been proposed as one possible solution to overcome the limitations of finite element method in surgery simulation where the analysed continua (organs) undergo large local deformations and rupture/dissection due to interactions with surgical tools, and where the computational grids for complex geometries of the body organs need to be created rapidly by a personnel with little expertise in computational mechanics. So far, the results have been encouraging. However, unlike for finite element method, there are no dedicated pre- and postprocessors for meshless algorithms that would facilitate creation of the models implemented using such algorithms and visualisation of the results obtained using the models.

This project focuses on creating (or adopting existing ones) algorithms for building computational grids and pre- and post-processor for Meshless Total Lagrangian Explicit Dynamics (MTLED) framework developed at the UWA Intelligent Systems for Medicine Laboratory (ISML) to facilitate efficient creation of computational biomechanics models using MTLED and visualisation of the results obtained using such models. It is expected that the project will results in well documented open-source code (or subroutines) that can be used by collaborating research groups and international biomechanics research community.

Xiao, Gongkui (James), Dr.

May, Eric, Prof.

Integrated Acid Gas Removal and Dehydration for LNG Production

Disciplines: Chemical

Acid gases carbon dioxide and hydrogen sulphide need to be removed from natural gas for LNG production because of their corrosive nature. Water needs to be removed for LNG production to reduce the chances of blockage in processes. Currently in LNG industry, acid gases are removed by an energy intensive liquid circulation process and then the water in the sweet gas streams is removed by a temperature swing adsorption process. Integrated membrane and adsorption processes may be deployed for the removal of acid gas and water, with potential in reducing footprint of process units and operating costs.

Xiao, Gongkui (James), Dr.

May, Eric, Prof.

Hybrid system for biogas upgrading

Disciplines: Chemical

Biomethane production represents a promising form of renewable energy. Biomethane is an upgraded product of biogas that contains various levels of impurities such as CO2, N2, H2S, H2O, VOCs etc. To efficiently remove these impurities, a hybrid system combining membrane and pressure swing adsorption technology is being developed to obtain the advantage of each technology in one plant for biogas upgrading.

Xiao, Gongkui (James), Dr.

May, Eric, Prof.

Development of efficient design processes for hydrogen recovery

Disciplines: Chemical

Prerequisite skills: Programming (MATLAB or Python)

Hydrogen is commonly deemed as a green energy source. Currently about 95% of the hydrogen production in the world is from methane reforming. Because methane reforming process is a thermal process, the produced hydrogen is accompanied with impurities such as CO2, CO, CH4, N2, etc. Pressure swing adsorption (PSA) processes are used to recover and purify the hydrogen. However, the design of a H2PSA process is time consuming and experience based, this project intends to apply machine learning in the design of H2PSA to achieve efficient process plant design for different feed gas conditions.

Zhang, Dongke, Prof

Zhu, Mingming, Dr

Okoye, Chiemeka, Dr

Manufacturing of carbon black by partial combustion of heavy fraction of spent tyre pyrolysis liquid

Disciplines: Mechanical, Chemical

The disposal of biomass and industrial wastes, such as forestry by-products, agriculture residue, municipal wastes, spent tyre, represents a major environmental issue throughout the world. Pyrolysis is a simple, robust, and scalable approach for simultaneous production of gas, liquid and char. After desulphurisation and extraction of high value chemicals, the remaining heavy residue of the pyrolysis liquid still contains a high amount of PAHs, a great source material for carbon black production. This project will focus on the manufacturing of carbon black by partial oxidation of the heavy liquid residue.

Sub-project 1: effect of temperature on the yield of carbon black

The objective of this sub-project is to experimentally study the effect of temperature on the yield and properties of carbon black produced. The experiments will be conducted using a laboratory scale burner simulating industrial carbon back manufacturing process. The burner will burn pyrolysis gas with air to provide high temperature flame. The heavy pyrolysis liquid fraction will be injected into the burner and pass through the high temperature flame to make carbon black. The carbon black will be produced at various flame temperatures and then characterised for its physical and chemical properties. In this sub-project, the yield of carbon black will be evaluated and the carbon black will be characterised for proximate and ultimate analysis and BET surface areas.

Sub-project 2: effect of temperature on the properties of carbon black

The objective of this sub-project is to experimentally study the effect of temperature on the yield and properties of carbon black produced. The experiments will be conducted using a laboratory scale burner simulating industrial carbon back manufacturing process. The burner will burn pyrolysis gas with air to provide high temperature flame. The heavy pyrolysis liquid fraction will be injected into the burner and pass through the high temperature to make carbon black. The carbon black will be produced at various flame temperatures and then characterised for its physical and chemical properties. In this sub-project, the carbon black will be characterised for its pH value, loss on heating and particle size distribution.

Sub-project 3: effect of residence time on the yield of carbon black

The objective of this sub-project is to experimentally study the effect of temperature on the yield and properties of carbon black produced. The experiments will be conducted using a laboratory scale burner simulating industrial carbon back manufacturing process. The burner will burn pyrolysis gas with air to provide high temperature flame. The heavy pyrolysis liquid fraction will be injected into the flue gases with the high temperature to make carbon black. The carbon black will be produced with various residence times by varying the gas velocity and then characterised for its physical and chemical properties. In this sub-project, the yield of carbon black will be evaluated and the carbon black will be characterised for its proximate and ultimate analysis and BET surface areas.

Sub-project 4: effect of residence time on the properties of carbon black

The objective of this sub-project is to experimentally study the effect of temperature on the yield and properties of carbon black produced. The experiments will be conducted using a laboratory scale burner simulating industrial carbon back manufacturing process. The burner will burn natural gas with air to provide high temperature flue gas. The heavy pyrolysis liquid fraction will be injected to locations in the high temperature to make carbon black. The carbon black will be produced with various residence times by varying the gas velocity and then characterised for its physical and chemical properties. In this sub-project, the carbon black will be characterised for its pH value, loss on heating and particle size distribution.

Zhang, Dongke, Prof

Zhu, Mingming, Dr

Sugiarto, Yusron, Dr

Two-phase anaerobic digestion

Disciplines: Chemical, Mechanical

Two-phase anaerobic digestion (TPAD) is expected to produce hydrogen-enriched biogas, which has higher quality and more ideal combustion properties than biogas produced from conventional single-phase anaerobic digestion. The preliminary studies at the Centre for Energy have found that biochar addition promoted both H2 and CH4 production in TPAD. This project will investigate the effect and working mechanisms of biochar addition on TPAD under different operational conditions. This project will also investigate biogas cleaning using biochar.

Sub- project1: Understanding the role of biochar on hydrogen and methane production

Our previous studies have found that adding biochar into two-phase anaerobic digestion process can enhance both hydrogen and methane production. Continuing the inquiry of this line, this sub-project is designed to understand the working mechanisms of biochar on both hydrogen and methane production from bench scale TPAD of food waste. The biochar will be leached to remove nutrients and the leached biochar will be added to bench scale H2 and CH4 production reactor. The gas volume and compositions will be measured daily using water displacement methods and GC, respectively. Volatile fatty acid (VFA) and pH as a function of time will also be monitored periodically. The microbes during anaerobic digestion process will be determined.

Sub-project 2: Commission and operation of a laboratory reactor to produce hydrogen and methane from food waste

The aim of the sub-project is to commission and evaluate the performance of a laboratory scale 5L reactors simulating TPAD process. The system consists of a hydrogen-producing reactor and a methane-producing reactor. The system will be commissioned to realise biogas

production (H2 production in the first reactor and CH4 production in the second reactor). The gas volume and compositions will be measured daily using volumetric gas gauge and GC, respectively. Volatile fatty acid (VFA) and pH changing will also be monitored periodically.

Sub-project 3: Effect of biochar on the hydrogen sulfide (H2S) removal from biogas using bench scale and pilot scale biogas cleaning unit

The aim of the sub-project is to use biochar to remove H2S in biogas. The experiments will be conducted using bench scale column reactor. The gas composition will be measured using mass spectrometer and the efficiency of H2S removal will be calculated. The effect of type of biochar and addition ratio of biochar and gas retention time on H2S removal efficiency will be determined

Sub-project 4: Effect of biochar on ammonia (NH3) removal from biogas using bench scale and pilot scale biogas cleaning unit

The aim of the sub-project is to use biochar to remove NH3 in biogas. The experiments will be conducted using bench scale column reactor. The gas composition will be measured using mass spectrometer and the efficiency of NH3 removal will be calculated. The effect of type of biochar and addition ratio of biochar and gas retention time on NH3 removal efficiency will be determined.

Zhang, Dongke, Prof

Zhu, Mingming, Dr

Zhang, Zeno, Mr

NH3 as a clean transport fuel

Disciplines: Chemical, Mechanical

In a carbon-constrained world, there are two strategies for de-carbonisation of transport: (1) electrification and (2) carbon-free alternative fuels. In the concept of "hydrogen economy", hydrogen is considered as the ultimate carbon-free fuel and energy carrier for both transport and electric power applications. However, the fact that pure hydrogen does not exist naturally and has a low volumetric energy density, even in the liquid form under cryogenic conditions, means that hydrogen is faced with immense technical, economical and infrastructure challenges before it can play a major role in powering transportation. It appears that hydrogen would require a suitable carrier. With its high content of hydrogen per unit of mass or volume, ammonia (NH3) is an excellent H2 carrier for easy storage, transport and distribution of hydrogen. In fact, NH3 itself is a carbon-free liquid fuel that can be used in internal combustion (IC) engines. As a fuel for combustion in IC engines, it suffers from high ignition energy, narrow flammability limits, low flame temperature, low burning rate, and potentially high NOx emissions. It has been found that a small amount of H2 addition can promote combustion of NH3. The required H2 can be obtained directly by partially dissociating NH3 in-situ to produce an NH3/H2 mixture before injection into the engine cylinders. This project is

designed to study the effect of H2 on the basic ignition and combustion characteristics and NOx formation and destruction of NH3.

Sub-project 1: Effect of H2 on flammability and minimum ignition energy of NH3

The objective of this sub-topic is to study the effect of H2 on the flammability and minimum ignition energy of NH3. The experiments will be conducted using the Hartmann bomb system. The effect of equivalence ratio, initial H2 concentrations in the mixtures, and initial temperature on the flame speed will be studied.

Sub-project 2: Effect of H2 on NOx formation and destruction

This sub-project is aimed to study the effect of H2 on NOx formation and destruction in NH3 combustion. The experiments will be conducted using a Bunsen burner. The concentration of NOx of premixed NH3/air and NH3/H2/N2/air flames will be collected and quantified using a NOx analyser. The effect of equivalence ratios, initial H2 concentration in the mixtures, and initial temperature will be studied.

Sub-project 3: Kinetic modelling of ignition and combustion and NOx formation of NH3/H2/NOx/N2/O2 mixtures

This sub-project is designed to investigate the ignition and combustion characteristics of NH3 and effect of H2 and NOx as combustion promoters using kinetic modelling to understand chemistry and reaction mechanisms. The student is expected to (1) conduct a detailed literature review on the combustion characteristics of NH3, NOx formation and reaction mechanisms of NH3/H2/N2/NOx; (2) study the effect of H2 and NOx on the laminar flame speed, ignition delay times, flame temperature and NOx emission as a function of initial temperature, equivalence ratio, H2 or NOx ratio in the fuel mixtures through kinetic modelling using commercial software Chemkin Pro. The data will be validated against the experimental results.

Sub-project 4: Experimental and kinetic modelling of NOx reduction by NH3

The objective of this sub-topic is to study the effect of NOx reduction by NH3. The experiments will be conducted using a plug flow reactor and the kinetic modelling will be performed using commercial software Chemkin Pro. The effect of temperature, NH3 concentrations and residence time on the NOx reduction will be studied.

Zhang, Xinan, Dr

Control and Modulation of Hybrid Energy Storage System in DC Microgrids

Disciplines: Electrical & Electronic

Prerequisite skills: Matlab/Simulink, Electrical circuit simulation and analysis

Energy storage systems (ESSs) are indispensable components in modern microgrids. They are introduced to improve system power quality, reliability and stability. For better cost-effectiveness, hybrid ESSs are widely studied in recent years. Two of the main challenges of hybrid ESSs in microgrid context are the grid integration via power converters and the coordinating control of different ESS. To overcome these challenges, this project proposes two solutions as Parts I and II of the project. Part I focuses on the investigation of modulation techniques that reduce the power loss of converter circuits, which are used to interface the hybrid ESSs to DC microgrids, through appropriate switching pattern of power semiconductors; while Part II studies the control methods that can coordinate different ESSs in a cost effective manner.

Zhang, Xinan, Dr

Control and Modulation of Five-level Inverter for Medium Voltage DC System

Disciplines: Electrical & Electronic

Prerequisite skills: Matlab/Simulink, Electrical circuit simulation and analysis

Multi-level inverters are increasingly popular for modern high voltage/high power systems, such as the medium voltage DC vehicular power systems and offshore wind generation systems. One of the most widely used multi-level inverters is the ABB five-level neutral point clamped inverter ACS-2000. It contributes to interface the high voltage/power three-phase electrical sources/loads to medium voltage DC system in a cost effective manner. The main technical challenges for this converter topology are enumerated as (1) robustness of control system that avoids performance degradation in presence of parameter variations; (2) comparatively high switching losses of power semiconductors due to the employment of many semiconductor switches.

To overcome the afore-mentioned challenges, this project investigates the robust control algorithms in Part I and low switching loss modulation technique in Part II.

Zhang, Xinan, Dr

Iu, Herbert, Prof

Adaptive Control Algorithms of Power Electronic Systems with Observer or Learning Capability

Disciplines: Electrical & Electronic

Prerequisite skills: Matlab/Simulink, Electrical circuit simulation

In the past decades, the closed-loop controlled power electronic systems are penetrating in modern power grid, home appliances and electrified transportation. Although the hardware design of many power electronic systems has been greatly improved with the invention of new materials and tools,

their corresponding software controllers are progressing at a comparatively slow pace. In practice, most of the existing power electronic systems are still using the classical proportional-integral (PI) controller, which suffers from poor dynamics, low robustness and deteriorated stability conditions with nonlinear loads. To effectively solve the problems of PI controller, this project explores the design and application of advanced adaptive controllers. Different control algorithms will be explored and compared.

To be specific, Part I of this project investigates the adaptive control approach with disturbance observer. It observes the load dynamics to enhance the dynamic performance and stability of the system. Moreover, system parameter variations will also be captured by the observer for better robustness. Part II of this project investigates the real-time learning based control algorithm that can autonomously tune the controller gains based on data samples. It simultaneously enhances the robustness, stability and overall performance of power electronic systems.

Zhou, Tongming, Prof

Wake flow and force characteristics of a circular cylinder covered with hard marine growth

Disciplines: Civil, Mechanical

Prerequisite skills: Civil Hydraulics

Vortex shedding is a phenomenon which occurs when a flow passes a bluff body. The shedding process can induce vibration, normally termed as vortex-induced vibration, or VIV which can result in excessive motion and possible structural failure. Marine growth, such as mussels, will develop on offshore pipelines and risers over a short period of time. The growth may change the hydrodynamic and VIV characteristics of the marine structures. In the present project, hard marine growth, which can be simulated using artificial materials, will be attached to the circular cylinders and tested in fluid flow for VIV and force characteristics. Particle image velocimetry and hot wire techniques will be used to examine the wake features after the control is used and the results can then be compared with that of a bare pipe.

Zhou, Tongming, Prof

Wake flow and force characteristics of a circular cylinder covered with soft marine growth

Disciplines: Civil, Mechanical

Prerequisite skills: Civil Hydraulics

In this project, soft marine growth, e.g. seaweed, which can be simulated using artificial materials, will be attached to the circular cylinders and tested in a wind tunnel for VIV and force characteristics. Hot wire techniques will be used to examine the wake features after the control is used and the results can then be compared with that of a bare pipe.

Zhou, Tongming, Prof

Enhancement of vortex-induced vibration using passive method for energy harvesting

Disciplines: Civil, Mechanical

Prerequisite skills: Civil Hydraulics

Vortex shedding is a phenomenon which occurs when a flow passes a bluff body. The shedding process can induce structural vibration, normally termed as vortex-induced vibration, or VIV. In many cases, VIV will influence the life span of a structure. However, from the point of view of energy generating and harvesting, VIV can be enhanced to promote the conversion of mechanical energy to electric energy. In this case, methods should be used to enhance VIV of a structure. In this project, students will work in a group to test a few methods for enhancing VIV and to explain the physics behind this through experiments in a wind tunnel.