Flinders University | College of Science & Engineering

College of Science and Engineering
Summer Research Award

Project Booklet
2022 - 2023

Flinders University | College of Science & Engineering

An Introduction to the College of Science and Engineering

At the College of Science and Engineering we believe in the power of science and engineering to solve real world problems.

We strive to advance fundamental science, to create new technologies, and to work across discipline boundaries. Our interests scale from the sub-atomic through to entire oceans, forests and beyond. We seek to understand the past, but also to create the world of the future.

Our researchers seek to discover new understandings in fields as diverse as groundwater hydrology, forensic science and medical devices, while our teaching offers training in areas of biological sciences, chemical and physical sciences, computer science, information technology, engineering, mathematics and the environment.

Our college is an exciting place to research, study and work, supported by best practice teaching methods, practical work-related learning and advanced facilities.

We are the power behind creative science and engineering.

Our Research Sections

Our talented researchers span across all spheres of science and engineering and bravely pursue solutions to some of the biggest questions of our time. With a broad focus on sustainability, security and health, our research advances knowledge, addresses real world problems, and promotes sustainable development.

Our multidisciplinary research sections provide areas of foci for our research community and encompass the following:

Data and Information Systems

We focus on the integration of cybersecurity, machine learning and advanced data analytics to solving important and wide-reaching industry, government, and defence problems.

Our mathematicians and computer scientists are conducting world-leading research in artificial Intelligence, knowledge discovery, medical image processing, neuroscience, and cybersecurity. Our experts in digital health are making significant contribution to healthcare service delivery world-wide, creating new systems for data security, virtual care and digital infrastructure.

Conducting inter-disciplinary and collaborative research, we translate our research into tangible outcomes with broad impact for the benefit of the professions and the community.

Ecology, Evolution and Environment

We do world-leading research in several areas of biodiversity and environmental sciences, including palaeontology, evolutionary biology, global ecology, molecular ecology, animal behaviour, groundwater and coastal geomorphology. Our research is expanding knowledge about the history of life and the potential of organisms to adapt to environmental change. We are also interested in improving water management and understanding the impact of human activities on the physical environment, biodiversity and natural resources. Our research section consists of around 180 academics, postdocs and research students housed at the leafy surrounds of the Flinders University campus at Bedford Park.

Engineered Systems

By combining fundamental research with the application of state-of-the-art engineering principles, we are developing new technologies and making new breakthroughs in Biomedical, Civil & Environmental, Electrical & Electronic, Control, Mechatronics & Robotics, Materials, Mechanical & Manufacturing Engineering. Based at Tonsley, Australia's first Innovation District, our research incorporates strong collaborations with industry, across Australia and internationally.

Molecular Science and Technology

We are also committed to translating this fundamental research into a wide array of real-world applications and impact. Our chemistry and physics discoveries have led to new nanotechnology for environmental remediation, energy production and storage, and advanced materials. Our biochemical research has made an impact on how we view and treat disease. Our forensic science research has provided innovative solutions for fighting crime. Our plant science research has made advances to support the future of food production.

We are forward-thinking and aim for scientific and technological advances for solutions spanning health, development, security and sustainability.

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Supervisors and their Summer Research Award Projects

Research Project Title:

Dye sensitized solar cells

Supervisor:

Prof. Gunther Andersson

Email: gunther.andersson@flinders.edu.au

Phone: 8201 2309

Project Summary:

Dye sensitized solar cells (DSCs) are one of the promising technologies for photovoltaic cells. The interface of the titania and the dyes in DSCs is the crucial place for their functionality and efficiency. Interfaces in dye sensitized solar cells: the morphology of dye layers on titania (thickness, coverage and homogeneity) and the electronic structure will be investigated with depth profiling techniques and electron spectroscopy.

This is a project in collaboration with Prof Lars Kloo (Sweden).

Basic knowledge in Physics or Chemistry (first year level) would be expected.

Research Project Title:

Nano clusters for fabrication of solar fuels

Supervisor:
Prof. Gunther Andersson
Email: gunther.andersson@flinders.edu.au
Phone: 8201 2309

Project Summary:

We are developing catalysts for converting CO2 and H2O back to hydrocarbons, thus develop processes to fabricate solar fuels. The main components are small metal clusters which act as catalysts. The clusters contain only 4 – 100 metal atoms. We can be fabricated the clusters with physical methods in a cluster source or use chemically made clusters.

The project is a collaboration between Flinders, Adelaide University, Canterbury University, Newcastle University, the University of Utah (USA) and the National Institute for Material Science (Japan).

Basic knowledge in Physics or Chemistry (first year level) would be expected.

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Research Project Title:

Determining sea spray compositions

Supervisor:

Prof. Gunther Andersson
Email: gunther.andersson@flinders.edu.au
Phone: 8201 2309

Project Summary:

Sea spray aerosols alter climate and the environment in remarkable ways. Marine aerosol particles are created by breaking ocean waves. This top region of the ocean is rich in organic molecules. The breaking waves transfer this biological soup into the droplets as they are jettisoned from the ocean surface. Water droplets can act as miniature catalytic converters for interfacial reactions.

The aim of this project is to determine the composition of water droplets directly.

Our depth profiling method will be applied in collaboration with Prof Gilbert Nathanson (Madison, USA).

Basic knowledge in Physics or Chemistry (first year level) would be expected.

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Research Project Title:

New marine antibiofouling coatings

Supervisor:

Prof. Mats Andersson

Email: mats.andersson@flinders.edu.au

Phone: 8201 3585

Project Summary:

Fouling (the growth of marine organisms) onto ships is a serious problem that dramatically increase fuel costs, loss of manoeuvrability, damage and spreading of invasive species. To overcome this problem the current method uses biocides such as copper compounds in the antifouling paint. The problem with this method is that it increases the level of copper in harbors and marinas. High copper level in the water is a serious environmental concern, and such coatings are now banned in different parts of the world.

The focus of this project is to study and develop new coatings that can be used to prevent the growth of unwanted marine organisms onto different surfaces, for example ship hulls.

This research is performed in collaboration with the defence industry in South Australia and is supported by the Australian Research Council.

Suitable background: Chemistry

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Research Project Title:

Fabricating flexible polymer solar cells

Supervisor:

Prof. Mats Andersson

Email: mats.andersson@flinders.edu.au

Phone: 8201 3585

Project Summary:

Polymer solar cells have gained considerable interest during the last decades. This project is focused on optimizing printing methods for preparing polymer solar cells on flexible plastic substrates. Special emphasis will be on preparing stable and efficient solar cells using environmentally friendly fabrication processes.

This project offers an opportunity to learn about conjugated polymers, how polymer solar cells works, as well as getting hands on experience with fabrication and characterization of polymer solar cells.

Suitable background: Chemistry and/or Physics.

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Research Project Title:

Recycling of valuable materials in silicon solar cells

Supervisor:

Prof. Mats Andersson

Email: mats.andersson@flinders.edu.au

Phone: 8201 3585

Project Summary:

Silicon solar cells have had a tremendous success in generating renewable energy. They are now common on household and industrial roof tops and in large power generating plants. The lifetime of these solar cells is long but already today they start to be a waste problem, and this is a problem that will grow. What can be done with the silicon solar cells after they have finishes working properly?

This project focuses on how to recover the valuable material in the solar cells such as silver and the silicon. Different methods to extract and recover silver will be evaluated and tested.

Suitable background: Chemistry

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Research Project Title:

Investigating the use of non-local neural networks in prostate cancer classification using Deep Learning models

Supervisor:

Dr. Mariusz Bajger and Dr. Gobert Lee

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Phone: 8201 3984; 8201 2410

Project Summary:

Deep Learning techniques has proven to be useful in many biomedical imaging tasks including analysis of histopathology images. They often outperform classical machine learning techniques and are currently the most accurate tools to detect and classify prostate cancer in histopathology images. At the moment the Gleason grading system is the most effective way of measuring aggressiveness of prostate cancer. It has five grade groups form grade 1 - the outstanding recovery prognosis to the grade 5 - the worst recovery prediction. Many Gleason grading systems were proposed but none of them has high both sensitivity and specificity. Therefore, it remains a challenge for researchers to design a better system.

The project will look at the feasibility of improving some best performing deep learning based Gleason grading systems by incorporating non-local neural blocks. This will enable the system to utilize global image information more effectively and potentially increase specificity and sensitivity of such a system. Publicly available datasets will be utilized in the project.

Background required: deep/machine learning, digital image analysis, Python programming.

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Research Project Title:

Designing nano-cage adsorbents for the capture of perfluoroalkyl pollutants

Supervisor:
Dr. Witold Bloch
Email: witold.bloch@flinders.edu.au

Project Summary:

Environmental contamination by a toxic group of chemicals called perfluoroalkyl substances (PFAS) has emerged as a widespread economic and health burden in Australia and globally. PFAS have accumulated in the environment and leached into waterways due to their historical use as surfactants in manufacturing and in aviation fire-fighting foams. Although strategies to remove long-chain PFAS (six of more carbons) already exist, these treatments are ineffective for short-chain PFAS (five or less carbons).

The overarching aim of this project is to address the increasing accumulation of toxic organic pollutants in drinking water by examining the capture of PFAS within supramolecular cage compounds. In further stages of the project, these cage compounds will be used for the development of adsorbent materials for water purification.

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Research Project Title:

Stereocontrolled photoredox catalysis

Supervisor:

Prof. Michelle Coote

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Phone: 8201 5841

Project Summary:

Photoredox catalysts are photocatalysts that activate compounds by receiving or donating an electron from the substrate to trigger chemical reactions that would otherwise require much harsher conditions, or simply not occur at all. Many such reactions use low catalyst loadings, proceed at ambient temperature, and are amenable to flow processes, thus making them commercially and environmentally attractive. However, a considerable drawback of most existing photoredox processes is the inability of the photoredox catalyst to direct the stereoselectivity of the reaction in the absence of other chiral additives.

This project will use computational chemistry to design potent visible-light photocatalysts that retain the advantages of standard photoredox catalysis but with the added ability to intercept and, thus control, reactive intermediates in situ. This will be achieved by using co-ordinately unsaturated compounds capable of undergoing inner-sphere electron transfer instead of the usual outer-sphere processes.

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Research Project Title:

Linking sharks and ray microbiomes to measures of health

Supervisor:

Prof. Elizabeth Dinsdale

Email: elizabeth.dinsdale@flinders.edu.au

Project Summary:

The health of marine organisms is important to the health of the ocean, but difficult to measure. How do you tell if a 4 m long tiger shark is healthy? You will work with a team that is comparing microbial abundance with health measures, such as heavy metal concentration. We have multiple shark species to analyze.

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Research Project Title:

Summer Phage Hunters

Supervisor:

Prof. Robert Edwards and Dr. Sarah Giles
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Phone: 8201 3417; 8201 7991

Project Summary:

Interested in getting more hands-on biology experience? Come and start with a summer project in our lab. Achromobacter, Stenotrophomonas, Pseudomonas, and Staphylococcus are different kinds of bacteria that commonly cause disease in South Australia. These bacteria have also become resistant to many of the common antibiotics that doctors prescribe. Phage therapy is an alternative to antibiotic treatment (https://youtu.be/YI3tsmFsrOg), where we can use viruses (phages) to kill the bacteria. To make phage therapy work, phages are isolated from different places, and grown on the bacteria in the lab (https://www.youtube.com/watch?v=kPqbcvCTE80). We sequence their genomes to find out if they contain nasty genes.

In this project, you will collect samples, test them against different bacteria that from patients to see if we can find phages. You will purify your phages and give them a name. Then, you'll isolate the DNA from them and sequence it on the Nanopore sequencer. Finally, we'll do some bioinformatics to see if your phages would be suitable for use in a patient. You never know, one day the phage you find might be injected into someone's arm to treat them!

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Research Project Title:

Diagnose soil health conditions from self-potential signals

Supervisor:

A/Prof. Huade Guan

Email: huade.guan@flinders.edu.au

Phone: 8201 2319

Project Summary:

Electrical potential anomalies can naturally occur in soil due to water movement, solute diffusion, redox reactions, and microbial activities. Contaminants in soil can cause hydrochemical reactions, leading to self-potential (SP) anomaly. In root zone, fertilisers and microbiome can generate chemical gradients resulting in self-potential anomaly. These electrical self-potential signals can be measured with inexpensive technology. A Master student project last year has shown some promising signs for using SP to detect PFAS presence and different fertilisation levels in soil. We are now developing an internationally collaborative project, involving researchers from USA and France. Our aim is to develop reliable SP-based methods to detect contaminants in soils, estimate nutrient and organic carbon in soils, and to diagnose adverse conditions beyond moisture and salinity in crop root zone. We welcome students to join this exciting new methodology development.

Co-supervisors will be invited based on the target variables (e.g., nutrients, microbes, or contaminants) on which the project will focus on.

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Research Project Title:

Natural Microbial and Geochemical Process for Attenuation of Metalliferous Mine Drainage

Supervisor:
Prof. Sarah Harmer
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Phone: 8201 5338

Project Summary:

This project will evaluate a closed mine in the Pilbara as a pilot project for an extended ARC Linkage Project application. The project aims to:
1) Complete aquatic risk assessment, define source-pathways-receptors that present risks,
2) Determine if receptor environment or pathway of contact water can be modified to reduce risks ("risk management"),
3) On the basis of these studies, assess the long-term environmental safety of continuous delivery of mine void water to Gogo Dam in relinquishment of the site.

Geochemical studies will focus on (i) mineralogy of the mine as sources of Pb, Cd, Zn, Tl, As, (ii) formation of secondary mineralisation in the outflow channel and (iii) biogeochemical mineralisation in the existing wetlands.

Microbiological studies will accurately assess the ecology within (i) the mine void outflow waters, (ii) through the drainage channel to (iii) the existing wetland. The focus will be on assessing geochemical stability and risk of remobilization of deposited metals along the flow path. These studies will establish the biogeochemical cycles occurring, climatic variations, the performance of the existing wetland and attenuating current mechanisms.

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Research Project Title:

Evolution and archaeology of Fowlers Bay dunefield and settlement

Supervisor:
Prof. Patrick Hesp and Dr. Graziela Miot da Silva
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Phone: 8201 3538; 8201 2146

Project Summary:

Fowlers Bay is dominated by a large, active transgressive dunefield which is migrating NE into the town of Fowlers Bay and has covered portions of the original 1800's town. The dynamics of the dunefield and definition of accurate rates of dune migration via GIS have already been carried out.

In this study a student will be supervised to conduct the following:
(i) An analysis of 2018 LiDAR data to build a digital ground model to form a 3D baseline digital elevation model of the area.
(ii) Conduct a detailed Ground Penetrating radar (GPR) survey of the dunefield to find the buried portion of the town and obtain a high resolution 3D radar imaging of the historic buried township.

The student will learn a range of GIS techniques, obtain field experience on the dunefield, learn radar and GPR techniques and analyses, archaeological survey methods, and assist in completing a very valuable applied research work by (a) discovering the historic buried portion of the town, and (b) aiding a local community understand the risks and hazards associated with the region where they live.

We have funding in place to support travel, accommodation, and food costs.

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Research Project Title:

Integrating Hand Tracking into Virtual Reality Applications

Supervisor:

Dr. David Hobbs and Mr. Thomas Beltrame
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Phone: 8201 3167

Project Summary:

Virtual Reality (VR) is an area of growing interest due to its cross-disciplinary applications in health, manufacturing, architecture, defence, marketing, and gaming, to name a few. As functionalities such as controller-less hand tracking become common, the applications to explore how humans engage and interact with virtual environments increase.

This project is designed to introduce a student interested in VR application development the opportunity to experiment with an Oculus Quest 2 VR Headset. This would be of significant benefit for a student interested in undertaking an honours or research project exploring the human-machine interaction in serious games.

The primary learning objectives would involve:
1. Learning how to develop applications accepting VR inputs
2. Learning how to program hand tracking functions into a VR application
3. Learning how to design VR applications enabling humans to become the controllers

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Research Project Title:

Data Mining

Supervisor:

A/Prof. Ingo Koeper

Email: ingo.koeper@flinders.edu.au

Project Summary:

This project will be undertaken in conjunction with industry partner Micro-X at Tonsley. Micro-X is a developer and manufacturer of novel X-ray imaging devices that utilise ground-breaking carbon nanotube technology.

The aim of this project is to analyse large sets of data collected at various stages of X-ray tube production and to identify patterns and relationships that may assist in predicting trends.

Experience in using Microsoft Excel and some basic statistics knowledge are desirable.

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Research Project Title:

Mock up Model of Backscatter X-ray Device

Supervisor:
A/Prof. Ingo Koeper
Email: ingo.koeper@flinders.edu.au

Project Summary:

This project will be undertaken in conjunction with industry partner Micro-X at Tonsley. Micro-X is a developer and manufacturer of novel X-ray imaging devices that utilise ground-breaking carbon nanotube technology.

The aim of this project is to design a mock up model of a backscatter X-ray device that can simulate how the device identifies objects.

The project encompasses the following tasks:
Software design/programming: programming the application, combining 3rd part applications, vision detection

Mechanical Design: basic CAD design, building a casing, painting, wire cutting foam, laminating/vinyl wrapping, model making.

Electronics: connecting components, wires and batteries.

Some basic programming and CAD design skills are desirable.

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Research Project Title:

Treatment effect on microplastics load in sewage sludge

Supervisor:

A/Prof. Ingo Koeper
Email: ingo.koeper@flinders.edu.au
Phone: 8201 2451

Project Summary:

This research aims to study the treatment efficacy on eliminating microplastics in solid waste at the wastewater treatment plant.

Students will learn to use some analytical instruments such as FTIR and Raman microspectroscopy, Flow Cytometry, and Pyrolysis-GC/MS. They will also gain knowledge in chemical techniques on how to isolate microplastics from environmental samples.

As this is an industry-based project, students will experience dealing with an industrial and environmental issue, as well as managing research project.

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Research Project Title:

Air trapping nanotextured surfaces for Nitrogen fixation

Supervisor:

A/Prof. Melanie MacGregor and Dr. Iliana Delcheva

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Phone: 8201 2574

Project Summary:

Nitrogen fixation is one of the key reactions enabling life on earth. Indeed, the reduction of atmospheric dinitrogen into ammonia, makes reactive forms of nitrogen available for plants and animals to grow. In 1920's the Haber Bosch process industrialised the nitrogen fixation reaction and thereby helped respond to the increasing food demand of the growing population. However, Haber Bosh process is very energy demanding (high pressure and temperature). In fact, it is estimated to be accountable for 2% of the world CO2 emission footprint.

Sustainable alternatives, where nitrogen reduction is achieved under ambient conditions, are therefore actively sought-after.

The proposed project aims to develop new catalytic materials capable of promoting air trapping in order to increase the yield of nitrogen reduction into ammonia. This project is conducted in collaboration with Prof Mougel and his team from ETH, Zurich. A range of nanoengineered metal surfaces will be created via electroetching and hydrophobized using plasma polymerization. The substrates that best trigger the formation of nanostructure-induced air pockets and the formation of superwetting states will be tested for nitrogen fixation.

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Research Project Title:

Health of the Adelaide Sanctuary dolphins and the Port River system.

Supervisor:
A/Prof. Luciana Moller
Email: luciana.moller@flinders.edu.au
Phone: 8201 3684

Project Summary:

Coastal and estuarine waters close to cities are exposed to various human pressures, with dolphins serving as bioindicators of their health. Adelaide's Port River system has high ecological significance but has been heavily modified.

The area is home to a small resident population of bottlenose dolphins, and in 2015 it was declared the Adelaide Dolphin Sanctuary (ADS). In recent years there has been increasing concerns about the dolphins' health, with many young individuals becoming ill and dying. There is limited understanding of what might be causing these mortalities, with the government calling for an investigation into the problem.

This project is using innovative and multidisciplinary methods to assess the health of ADS dolphins and investigate the cause and contributing factors to morbidity and mortality. The results will assist the government to identify and manage the issue, which will benefit the public, industries, and wildlife that rely on a healthy Port River ecosystem.

Research Project Title:

Applications of dinuclear gold-N-heterocyclic carbene (NHC) complexes in electrophotocatalysis

Supervisor:
Dr. Tom Nicholls and Prof. Justin Chalker
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Phone: - / 8201 2268

Project Summary:

The electrochemical synthesis of gold-NHC complexes has been described and this method will be applied to synthesise dinuclear gold-NHC complexes. The use of electricity to synthesise these complexes is favourable as toxic chemical redox agents can be avoided. These complexes will be extensively characterised and their potential as electrophotocatalysts will be determined.

The complexes with the most promising characterisation data will be screened in electrophotocatalysis towards the development of new synthetic methodology.

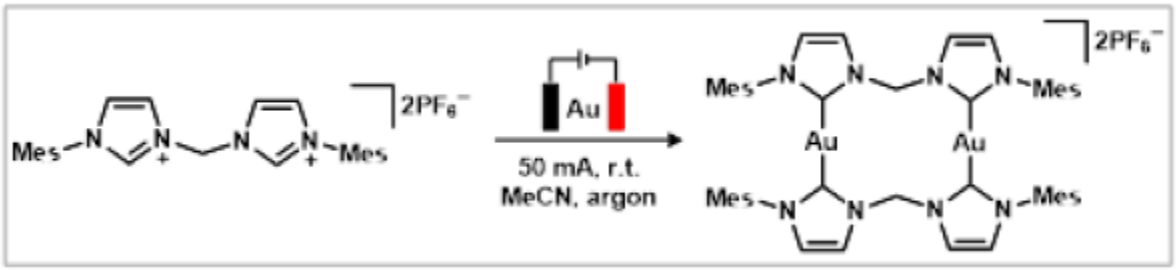

Figure 1. Electrochemical synthesis of dinuclear gold-NHC complexes.

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Research Project Title:

EEG ERP data collection and signal analysis

Supervisors:
A/Prof. Kenneth Pope and Ms. Bek O'Loughlin
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Phone: 8201 5042

Project Summary:

EEG is a commonly used modality for understanding how the brain works. It has significant advantages in terms of ease of data collection and in the time resolution that can be achieved. Different stimuli and tasks cause a range of different characteristic voltages (potentials) to appear in the EEG data, some of which are called event related potentials (ERP). ERPs are the potentials seen in EEG following the occurrence of a specific sense-based stimulus.

This project is designed to provide a student with a strong interest in neuroscience and signal analysis the opportunity to learn about EEG ERP data collection and signal analysis. This would be of significant benefit as preparation for a student who is interested in undertaking an honours project in this area.

The activities would involve:
1. Learning about EEG data collection and gaining experience in the processes.
2. Learning about standard procedures for handling and cleaning EEG data.
3. Experimenting with different protocol designs to record different ERPs.
4. Correlating their ERP findings with the current physiological understanding of the brain.

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Research Project Title:

EEG data collection and signal analysis

Supervisor:
A/Prof. Kenneth Pope
Email: Kenneth.Pope@flinders.edu.au
Phone: 8201 5042

Project Summary:

EEG is a commonly used modality for understanding how the brain works. It has significant advantages in terms of ease of data collection and in the time resolution that can be achieved. However, the collected data is very noisy. There are many standard techniques that are used to clean EEG data, some with complicated mathematical foundations.

This project is designed to provide a student with a strong interest in neuroscience and signal analysis the opportunity to learn about EEG data collection and signal analysis. This would be of significant benefit as preparation for a student who is interested in undertaking an honours project in this area.

The activities would involve:
1. Learning about EEG data collection and gaining some experience in the processes.
2. Learning about standard procedures for handling and cleaning EEG data.
3. Learning about the world-leading data cleaning processes we use at Flinders.
4. Learning about standard analysis techniques and experimental designs for understanding the brain.

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Research Project Title:

Thin film microfluidics - fundamental discovery of fluid flow and applications

Supervisor:

Prof. Colin Raston AO FAA

Email: colin.raston@flinders.edu.au

Project Summary:

We have developed a thin film microfluidic platform with applications in chemical synthesis, biochemistry, materials science, forensics, drug delivery, gene therapy, energy, food processing, rapid Covid-19 biomarker testing, and more. These applications have resulted in spin out companies, and industry funded projects as part of the ARC Centre of Green Chemistry Manufacturing. The fluid flow in this vortex fluidic device (VFD) is complex, arising from induced mechanical energy in a thin film (≥200 microns thick) in an inclined rapidly rotating tube, and understanding this is important in further advancing the applications. This aligns with a grand challenge in science, in understanding fluid flow. We have recently made a number of breakthroughs for VFD processing, including determining the sub-micron dimensions and topology of the fluid flow, making optically active materials, and how the Earth's magnetic field impacts on the chemistry. These contribute to predicting the flow parameters for a particular application. The research will focus on VFD fundamentals, including magnetic field effects, and/or applications to suite the interests of the awardee.

Research Project Title:

Evaluating antibacterial behaviours of a specified aggregation induced emission molecule

Supervisor:
Prof. Youhong Tang and Dr. Vi Khanh Truong
Email: youhong.tang@flinders.edu.au; vikhanh.truong@flinders.edu.au
Phone: 8201 2138

Project Summary:

Phototheranostics is a potential area for precision medicine, which has received increasing attention for antibacterial applications. Integrating all phototheranostic modalities in a single molecule and achieving precise spatial colocalization is a challenging task because of the complexity of energy dissipation and molecular design.

A type of quaternary amine functionalized aggregation-induced emission (AIE), AIEgen, was synthesized and used to produce singlet oxygen (1O2) and heat, which can be used to eradicate bacteria. With the introduction of the positive charge in AIEgen, AIE nanoparticles (AIE NPs) could selectively target bacteria. Notably, the AIE NPs displayed obvious antibacterial performance against Gram-positive bacteria and Gram-negative bacteria. The results can suggest the potential of AIE NPs acting as broad-spectrum antimicrobial materials, which provided a strategy for treating different microorganisms.

This project will be collaborated between Youhong Tang (Science and Engineering) and Vi Khanh Truong (Medicine & Public Health). Potentially, there will be some HDR students involved.

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Research Project Title:

Exoskeletons

Supervisor:

Dr. Robert Trott and Dr. David Hobbs

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Phone: - / 8201 3167

Project Summary:

There is growing interest in the use of passive and active assistive exoskeletons within industry and rehabilitation. With rising interest and applications there are growing concerns about the use of exoskeletons, whether or not they are beneficial over the long term, and how are they controlled. In an industrial setting control is often passive and assistance is dialled in manually. In medical settings, direct control is often taken away from the user, replaced with inputs akin to a joystick.

This project will see a student explore either industrial or medical exoskeleton human input devices and the fundamental control strategies they employ, and introduce them to control systems and the variants that exist, with the opportunity to implement a control technique(s).

It is expected that a student will build familiarity of the exoskeleton market and the controllers/control systems they employ and will gain practical knowledge on the application of these concepts. It is expected these learnings will provide foundational knowledge in the areas of human bio-mechanics, biomedical engineering, mechanical design and control theory; all having research currency.

Flinders University | College of Science & Engineering

Research Project Title:

Electromyography exploration

Supervisor:

Dr. Robert Trott and Prof. Karen Reynolds
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Phone: - / 8201 5190

Project Summary:

Electromyography (EMG) is an important tool for assessing local exertion for many activities including those using assistive devices such as exoskeletons. A major drawback of EMG sensors is that they must be aligned with the muscle being investigated (both have bipolar properties) at locations where there are other muscles, and this interferes with the signal. In many instances the muscles are layered. This may be an opportunity; intentionally aligning sensors with underlying muscles to maximise the strength of the "interfering" signal may provide an opportunity to separate these sources of interference from the target muscle. There are also areas of the body such as the shoulders where the underlying muscles are of interest but have historically been omitted because of poor access.

This project will see a student study the fundamental concepts of EMG, signal acquisition, processing and analysis in the above context. It is expected these learnings will provide foundational knowledge in the areas of human performance, biomedical engineering and signal processing all of which are valuable skills that have research currency.

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Research Project Title:

Human performance exploration

Supervisor:

Dr. Robert Trott and Dr. David Hobbs
Email: robert.trott@flinders.edu.au; david.hobbs@flinders.edu.au
Phone: - / 8201 3167

Project Summary:

Heart Rate (HR) and Heart Rate Variability (HRV) are metrics of human performance. The former is an excellent measure of global exertion and the latter has been used in many fields to quantify psychological and physiological stress. Both of these quantities are important in occupational settings; physiological performance when using augmenting devices such as assistive exoskeletons, and general stress levels when undertaking tasks with combinations of physical and mental workload. More recently a host of consumer devices have introduced the feature through wrist based measures that approximate the more accurate measure obtained from electro-physiology. The Polar H10 chest based heart rate monitor can be used to obtain the basic HRV measure and has an Application Programming Interface.

This project will see a student study the fundamental concepts of HRV, signal acquisition, processing and analysis while developing an interface to directly obtain the HRV measure and extract useful metrics. It is expected these learnings will provide foundational knowledge in the areas of human performance, biomedical engineering, programming and signal processing; all having research currency.

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Research Project Title:

Impacts of oceanic forces on seawater intrusion (SWI) in coastal aquifers

Supervisor:

Prof. Adrian Werner and Dr Amir Jazayeri
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Project Summary:

Fresh groundwater stored in coastal aquifers is widely used to meet the demands of urban, agricultural and industrial activities, and plays a critical role in the health of marine ecosystems through submarine freshwater discharge to the sea. Coastal groundwater resources are vulnerable to seawater intrusion (SWI); the landward incursion of seawater into coastal aquifers, resulting in reduced fresh groundwater. Critical knowledge gaps remain that limit the creation of sustainable groundwater management practices for coastal regions, particularly, the effects of tides on SWI processes remains largely unclear. This project aims to address critical knowledge gaps in the understanding of SWI within tide-affected aquifers, using physical experiments.
Further details can be found in Werner et al. (2013) through this link http://dx.doi.org/10.1016/j.advwatres.2012.03.004

These research proposals will be significant contributions to the knowledge base of the discipline and are appropriate for undergraduate students. The students will be based at Flinders University and will assist with the laboratory experimental work in our lab (located at Room 106A - Earth Sciences Building).

Flinders University | College of Science & Engineering

Research Project Title:

Investigation of sand dams on groundwater-surface water interactions

Supervisor:
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Project Summary:

The interaction between groundwater and surface water plays a critical role in the functioning of water resource systems. The aim of this research is to analyse the effects of temporary sand dams in the Burdekin River on river-aquifer interactions. This will contribute to a recently secured >$1M Australian Research Council grant to study the groundwater and surface water resources of the Lower Burdekin Delta, Queensland.

The student will be based at Flinders University (Bedford Park) and will assist with data analysis and modelling with team members located in the Earth Sciences building.

Flinders University | College of Science & Engineering

Research Project Title:

Build and Program the Digital Health Design Lab Robot Cat

Supervisor:

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Project Summary:

Technological advances in computing, sensors, and communication networks, coupled with breakthroughs in artificial intelligence and machine learning has broaden the scope of robotics beyond the domain of manufacturing.

Robots are replacements in situations that are laborious or too dirty and dangerous for humans. Robots are searching for survivors in tight unstable spaces of collapsed buildings or locating and deactivating landmines.

Today robotics are also being applied to knowledge and service activities including healthcare. The technology of robots may be used to prevent social isolation and depression and to prolong independent living.

This fun project is intended to introduce you to the basic concepts of robotics with hands-on experience. The project requires you to build a programmable quadruped cat robot (from a kit we provide). You will use a motion controller along with an extensible open source system to program the kitty using C++ or Python and an Arduino or Raspberry Pi. You will explore real world manoeuvrability and make your robot behave however you want while developing an understanding of robotics.