DEPARTMENT OF ELECTRONIC & ELECTRICAL ENGINEERING

University of Strathclyde Engineering

Strathclyde Game Changers

Internship Program

The University of Strathclyde is constantly looking to improve its research output and working environments. A key aspect of this is ensuring we build teams made up of diverse groups of thinkers and problem solvers, collaborating in supportive and inclusive environments. We know that the best results are achieved when different voices and different points of view are all brought together. In order to foster the next generation of **game changing** researchers, we have therefore established this internship program to demystify research and ensure the possibilities of academia are open to all.

This program offers fully funded 6 week internships, in areas of renewable energy research, to people between first year undergraduate and masters degree level studies at a Scottish university. Each project sees a candidate joining a Strathclyde research team and working alongside them throughout. Interns will have a chance to see, experience and contribute to real life research, gaining valuable insight into PhD studies and academic life. They will also learn valuable skills which can aid them in their studies and future projects they might undertake. Most importantly, these projects will help bring the world of research out from behind closed doors, exposing new minds to a world of possibilities where their skills and insight can provide huge contributions in the years to come.

Four funded places are available for the summer 2020 program. The projects themselves are detailed in the remainder of this document. Projects will take place for a period of 6 weeks between the months of June and September (inclusive). Individual projects can take place at a time which suits successful applicants, although every effort will be made to ensure that internships are concurrent to allow interns to mix with each other as well as their research groups.

In order to apply to a specific project, please send a covering letter (1 page max) and CV to the programme lead - Dr Edward Hart (edward.hart@strath.ac.uk). The covering letter should detail: why you are excited about the opportunity to work on your specified project, what skills or experience you have which you feel will help you succeed, and your thoughts on the importance of diversity and inclusion in a research setting and why you would like to take part in a scheme built around this goal. The application deadline is 5pm on Friday 17th April 2020.

Given the current Covid-19 situation, these internships may need to take place remotely and so candidates should ensure they can access a laptop or PC during the project. In this case, some aspects of the work plans may also need to change accordingly.

Project 1: Online identification of cascading events sequences in systems with renewable generation

Background and motivation

Electrical energy networks are going through unprecedented changes, mainly driven by the need for decarbonisation due to climate change, but also due to other technical, economic and social reasons. A significant number of Renewable Energy Sources (RES) are being connected to the electricity system, a lot of which in distribution systems. Furthermore, energy storage, electric vehicles, heat pumps, HVDC interconnectors, “smart grids” and associated control systems, will all act to increase the complexity and unpredictability of the system. These changes lead to increased uncertainty and complexity in power system dynamic behaviour and operation. This in turn can potentially lead to unforeseen dynamic interactions and sequential disconnection of power system components in order to protect them from damage (cascading failures) which in the worst case can lead to blackouts. This internship will be part of the EPSRC Supergen Energy Networks Hub project “Using machine learning to represent power system dynamics.” This project is a collaboration between the University of Strathclyde and the Alan Turing Institute to bring together the power systems and machine learning research communities to tackle this challenging problem through a Data Study Group (https://www.turing.ac.uk/collaborate-turing/data-study-groups). The project is also supported by National Grid.

What will you do?

The fast identification of impending instability and also an as precise as possible prediction of the cascading events that follow could provide vital information in exposing network vulnerabilities and designing corrective measures to increase system security and avoid cascading events from spreading and potentially developing into a blackout. The project aims at using machine learning to predict these cascading events, based on datasets generated by detailed time domain simulations of power system dynamic responses for up to hundreds of thousands of cases. You will be part of a research team working on the project and will help in generating and preparing the datasets that will be provided as input to the Data Study Group. The main aim of the internship will be to develop a useful tool to automate this process and visualise information. You will also be an active member of the research team, participate in meetings with partners of the project and potentially support the Data Study Group (depending on availability and timing of the Data Study Group).

Required skills and experience

This project is best suited for a student in their final years of study with a computer science, machine learning or general engineering background. Knowledge of Python and/or Matlab would be desirable but most important is enthusiasm to work and learn within a research team.

Project 2: Multi-rotor wind turbines: investigating optimal size and number of rotors

Background and motivation

In order to avoid the catastrophic effects of climate change, there needs to be a large step change in the deployment of renewable energy devices. Wide scale deployment of wind turbines is a key part of the puzzle, which results in a focus within the wind industry to lower the cost of energy. An innovative solution to help achieve significant cost reductions is the multi-rotor wind turbine (MRWT) concept. The idea is to have a large number of small turbines on one support structure instead of one large turbine. This results in a significant reduction in cost of materials required for key components (along with a long list of additional benefits) and could be the innovation that breaks down the barriers to increased wind energy deployment worldwide. There is an ongoing debate within the MRWT community as to whether it is best to have a high number of smaller turbines (around 100) in a MRWT or to have a smaller number of larger turbines (between 5 and 10). The aim of this project is to investigate how the cost of energy changes as you change the size and number of turbines used, and to find an optimal solution to the problem.

What will you do?

You will be working closely with a small research team at the University of Strathclyde to develop methods and techniques that can help solve this optimisation problem. There are many issues to be considered within this project that span a wide variety of subjects. There is potential to investigate any or all of the three main areas of this problem. They are:

1) How the costs of components change with size and number of rotors. This will involve assessment of how mechanical and electrical components scale and the effects on the overall design

2) Changes in the amount of energy that can be harvested from the wind with different sized rotors. This could involve simulations, analytical methods or other engineering models

3) How the cost of operations and maintenance changes with the size and number of rotors used. This may involve gathering relevant information from industry experts and experienced academics.

The research team will work closely with you to ensure that the correct knowledge and tools are available for this project. A holistic approach will be taken, so this project provides an excellent opportunity to further your knowledge in all areas of engineering. This in an opportunity to be part of a multi-disciplinary project that could have real world effects on the future of wind energy.

Required skills and experience

Candidates should have an interest in renewable energy technology, particularly in the area of novel solutions. A background in a STEM subject is preferable, but any other background that could be applied to this problem is welcomed. Enthusiasm and good communication skills are also desirable.

Project 3: A Darwinian approach toward the design of novel floating wind turbines

Background and motivation

What if a floating wind turbine were a living organism? What optimum shape would it evolve into, generation after generation, subject to the Darwinian pressures of harsh offshore metocean conditions, and the constraint to deliver clean, safe, secure, and affordable energy? Would this shape be similar to the configurations proposed at the moment? Unlikely, since these are basically "slightly adapted" oil & gas (O&G) configurations, evolved under a completely different context. So, how can we discover novel, unconventional optimum shapes for ORE devices, building upon the O&G experience, but eliminating its bias?

We need to adopt a novel, fundamental, prime-principle based framework, to translate the techno-economical requirements into "evolutionary pressures". This framework is currently being developed at the University of Strathclyde, named FEDORA (FundamEntal approach toward the Design of ORe devices) – and you will have the opportunity to contribute to its further development, focusing on one of the main areas: aerodynamics, hydrodynamics, structural dynamics, control systems, mooring dynamics, levelized cost of energy modelling, logistics constraints, manufacturability constraints,… and many others.

What will you do?

You will be given the opportunity to choose an area of focus within this exciting and multifaceted research program on which you will spend your time during this project. First, you will be supported through a review of the existing floating offshore wind turbine optimisation framework and become familiar with its implementation in Matlab, an appreciation for floating wind technology and the challenges it faces more broadly will also be fostered through guided study and meetings with your supervisory team. You will then be launching a range of optimisation simulations in order to explore possible new directions for floating offshore wind platform designs. Having generated a substantial results dataset, these outputs will be analysed in order to assess the impacts of the considered design variations.

Required skills and experience

An engineering background is desirable, as well as a working knowledge of Matlab programming and analysis, programming skills more generally will also be useful. In addition, candidates should be highly motivated, interested in novel solutions in renewables engineering and able to take initiative in their work.

Project 4: Innovative integration of electrical-thermal systems with composite materials

Background and motivation

Reduction in aircraft weight and improved overall aircraft efficiency are key to the reduction of fuel burn and hence greenhouse gas emissions from aircraft. The increased electrification of aircraft systems, combined with the use of lightweight, composite structures, are key enablers for this improved performance. In particular, future aircraft must meet ambitious targets set by the EU and NASA to reduce greenhouse gas emissions due to air travel, in turn supporting UN Sustainable Development Goal 9 on Industry, Innovation and Infrastructure. To date the structural and electrical and associated thermal management systems on aircraft have been kept independent, due to the poor electrical properties of carbon fibre reinforced polymer (CFRP) compared to traditional metallic structures. If structures with integrated electrical and thermal management systems can be developed, this will provide a significant opportunity to design optimised, lightweight systems, leading to a reduction in aircraft fuel burn and hence emissions. However, the development of such systems is underpinned by the capture and understanding of electrical and thermal properties of CFRP. At present, the mechanical properties of CFRP are well understood but the knowledge of electrical and thermal properties is limited. This understanding is key to the design of integrated electrical-thermal-structural systems, due to the high power levels (1.5 MW for state-of-the-art more-electric aircraft - for context, the same as a small housing estate), complexity of aircraft electrical power systems and the harsh environments that an aircraft electrical power system operates in.

What will you do?

The aim of this project is to develop an appropriate electrical and thermal model of CFRP, which will directly support the future design of integrated electrical-thermal-structural systems for light-weighting of future aircraft. The project will:

- Combine the experimental capture and analysis of the thermal and electrical response of CFRP with theoretical knowledge to develop models which can be used to inform the design of future electrical power systems integrated with CFRP.
- Provide an opportunity to gain experience working in an interdisciplinary, university research team environment combining electrical power systems with sensors and data acquisition with materials science (composites).
- Contribute to an active wider area of research of electrical power systems for aircraft in the Aero-electrical team within the Advanced Electrical Systems research group, and the Centre for Intelligent Dynamic Communications, both at Strathclyde.

Required skills and experience

Candidates should have completed their 3rd or 4th (if going onto 5th year MEng) of an undergraduate degree which includes Electrical Engineering (joint honours with other engineering disciplines is welcomed), have an interest in cross-disciplinary research and systems engineering, and the independent initiative to help develop the project in a supportive team environment. Some programming skills (e.g. Python or Matlab) are also required along with being comfortable working in an experimental laboratory environment and being able to communicate the results of your research to other members of the team both in informal discussion and more formal written reports and presentations.