E&I Research Studentship project proposal 2019

Project title: Development of state of the art deconvolution algorithms for overlapping residual stress measurements using Bayesian probability

Supervision Team:
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Project Highlights:

- Optimise measurements at world leading scientific instruments and potentially save millions of pounds and provide a step change in data quality and resolution.
- Produce algorithms for use by the wider Neutron user community.
- Opportunity to use International diffraction facilities in UK, France, Germany, USA and Japan [1].
- Develop programming and modelling skills desirable across many fields as well as experience using some of the world's leading scientific facilities.

Project Description:

Neutron diffraction is employed as a method for determining the internal stress state in engineering materials and components [2]. Because the access to neutron facilities is extremely costly there is a continuous drive to make measurements more efficiently, while competing with an industrial drive to know the internal stress state in more detail. By increasing the neutron beam size, the number of neutrons hitting the sample is increased and a satisfactory data set can be produced in a shorter time. However, this is achieved at the cost of spatial resolution, a trade-off that is therefore often unacceptable.

To combat this loss of spatial resolution, the step size between measurement points can be kept small, but this means there is inherent smoothing in the data. Consequently, detail and high stress gradients may be lost.

There is no reason why data from overlapping measurement points cannot be de-convoluted to provide high spatial resolution with rapid collection times [2]. However, due to the complex nature of the interaction of neutrons and matter, the complex design of neutron diffraction instruments and the 3-dimensional geometries involved, this innovation has yet to be achieved satisfactorily [3].

This project will be a collaboration with neutron beamline scientists at ISIS, the UK's world-leading neutron and muon source, and will involve spending time working in their state of the art laboratory. Experiments will be performed using the ENGIN-X diffractometer (as well as other central facilities around the world) and used as calibration and validation for the deconvolution algorithms developed.

The project will deliver new data analysis algorithms that will be integrated within software used to control and analyse neutron measurements made with the ENGIN-X and IMAT instruments at the ISIS Facility. This will provide an automatic pathway to impact across scientific and industrial communities. In particular, algorithms produced in the project will find applications in the aerospace and nuclear industries, to name just two, where the highest detail of internal stress measurement is essential to assure structural integrity of components. The new measurement approach will also be of interest to the advanced manufacturing community in the context of optimising surface machining and performance enhancement treatments.

Research Methods:

In this project state of the art deconvolution algorithms will be researched and implemented for the application of improving neutron diffraction experiments.

The majority of the research will be programming and modelling focused on carefully designed experiments performed for the purpose of validation and demonstration.

Indication of project timeline:

Year 1: Become accustomed with deconvolution methods, experiment design and optimisation and the neutron diffraction technique. Research will involve developing the initial versions of deconvolution software, becoming proficient in object oriented programming and finalising the research question and scope.

Year 2: Develop more complex deconvolution software, validation using neutron diffraction measurements from international research facilities, Report findings at international conferences.

Year 3: Further develop techniques to provide experiment and data treatment optimisation. Present findings to UK Neutron user groups and the wider scientific community, complete thesis write-up and release final versions of code to the community.

Background reading

[1] https://www.isis.stfc.ac.uk/Pages/Engin-X.aspx
[2] Moat R.J. Materials Science and Technology (2018), 34:5, 519-528
[3] Xiong et al J. Appl. Cryst. (2006). 39, 410–424

Candidate Applications

- An ideal candidate will hold an engineering, applied maths or materials degree and have experience of programming in Matlab, Python or similar platform. Must be willing to travel.
- 1000 word cover letter outlining how they are equipped in their educational background and expertise to conduct the research project,
- a CV including contact details of two academic references
- An Open University application form, downloadable from: http://www.open.ac.uk/postgraduate/research-degrees/how-to-apply/mphil-and-phd-application-process (Note: This is an Advertised studentship and you do not need to submit a proposal).
- IELTs English Language test scores on application. An average of 6.5 and no less than 6 in anyone of the four components. Applicant should have these results when applying.

Applications should be sent to **STEM-EI-Research@open.ac.uk** by 28 February 2019