Full project description for RS663

Hydrogen is one of the leading candidates for the propulsion of next generation aircraft. Airbus' Structures Test department is interested in continuously developing and refining an understanding of how materials and components behave when exposed to the cryogenic temperatures required to store hydrogen in its liquid form. The existing methods for instrumenting specimens for tests conducted at cryogenic temperatures are limited. Digital image correlation (DIC) is a non-contact optical measurement technique that can capture full-field displacement and strain on components under test. DIC is highly adaptable and is widely applied in mechanical testing when complex, non-uniform strain fields are expected and where point-based measurements (e.g. strain gauges) are insufficient. With the increasing need to test materials and components at cryogenic temperatures comes the need to instrument these tests with data-rich techniques that function in challenging cryogenic temperatures. The project will aim to develop novel approaches to enable the use of DIC during cryogenic mechanical testing and significantly advance the current instrumentation capabilities in preparation for testing the next generation aircraft.

DIC relies on good optical access and a well-sized, high-contrast pattern with the correct adhesion and deformability for the structure and durability for its environment. Depending on the materials of interest, the surface may become compromised in cryo-temperatures, hydrogen environment as well as the optics themselves, reducing the image quality. Equally *in situ* mechanical testing with any imaging techniques has its own challenges at low temperatures, e.g., thermal effects on the load train and sample mounts. The Team at the Biomedical Engineering Simulation & Testing Lab (BEST Lab), led by Dr Arora, are actively pushing the boundaries of DIC, as well as particle image velocimetry (PIV) and digital volume correlation (DVC) amongst other image-based experimental mechanics methods. Measurements in challenging conditions are a focus of the Team for >15 years. The challenge of cryo-imaging may require bespoke and novel solutions to the imaging setup. Such challenges working in extreme environments and translation from the lab to fieldwork have been addressed by the Team over the years. The Team has experience working on large structures and field tests, ensuring DIC best practice remains in place in practical industrial settings. Challenges with strain corrections due to variable distortions, pattern durability, application compatibility and technique effectiveness under controlled cryo-temperatures needs to be pursued in this studentship.

The BEST Lab forges a synergy of computational and experimental expertise to deliver fundamental insight, novel technologies, and translational research solutions. The BEST Lab provides a space for interdisciplinary researchers to grow ideas from concept through to manufacture, instrumentation, and testing, alongside advanced computational mechanics, machine learning, and data analytics workflows. For more information on the facilities, a virtual tour is available. The dynamic group (>20 PGR students and Research Staff) leverages expertise in both simulation and testing to deliver high-quality research outputs, as well as services and products, to meet the unique needs of our collaborators in industry. Therefore, there will be scope for the student to gain wider skills to work between teams in virtual testing and technique transfer to large-scale components. The Space can host equipment and people for specific projects to ensure translation of research methods from university to industry. Further support from the Advanced Imaging of Materials (AIM) Facility will enable deeper insight to material performance and failure through a variety of imaging techniques including micro-CT.

The sponsoring company, Airbus, will be engaged throughout in developing ideas and applications with regular reporting expected throughout the project by the successful candidate. The project will involve a 3-month placement at the Aerospace Integrated Research & Test Centre (AIRTeC) where the techniques can be developed and demonstrated in an industrial setting. AIRTeC is a £40 million state of the art facility designed specifically to provide the most advanced working environment and tools for Airbus, suppliers, partners and academia. Collaborating research groups and stakeholders from across disciplines in industry will regularly engage throughout to broaden the development opportunities of the candidate. By the end of the project, the candidate will have acquired a portfolio of skills and external collaborators that will provide a strong footing for future careers in either academia or industry. There is a wide range of expertise within the BEST Lab to support on specialist topics in this project as well as interdisciplinary skills development of the successful candidate.