EPSRC CDT in Distributed Algorithms

PhD Project: Towards Data Driven Aerodynamic Models: Data Fusion of Experiment and Simulation

University of Liverpool

PhD Student: Mehdi Anhichem
Project Partner: ARA (Aircraft Research Association)

Supervisors:
Sebastian Timme, University of Liverpool
Jony Castagna, STFC Hartree
Andy Peace, ARA

Project Description

This project has been developed by the University of Liverpool in partnership with STFC Hartree and ARA.

The digital age with ubiquitous physics-based computational engineering tools, such as computational fluid dynamics (CFD), machine learning algorithms and ever-increasing computing power, helped accelerate the development of novel technologies deployed in the civil transport sector, as well as in defence and security, to meet the most demanding economic, environmental and societal challenges.

One such example is when multidisciplinary CFD analysis is not only used routinely in the design of next-generation aircraft but also in the preparation of an experimental wind-tunnel test campaign to explore the parameter design space in a comprehensive and cost-effective manner, while ensuring the safe operation of the test.

It is inconceivable that high-performance aircraft (and many other game-changing technologies) can be designed without physical wind-tunnel testing. Indeed, practical numerical methods often lack either prediction accuracy or the capability to model some physical phenomena altogether, or both. On the other hand, physical wind-tunnel testing not only becomes expensive when rapid design changes are sought (for which numerical tools are better suited), but, just as numerical tools, are subject to various uncertainties stemming e.g. from wind-tunnel corrections to account for the effects of wall constraint and flow field modification due to the chosen measuring technique or the fundamental flow characteristics of the wind tunnel itself.

It is envisaged to first explore future algorithms, including AI surrogate models, for near real-time joint experimental/numerical data analysis, that is uncertainty-aware, robust and quantifiable, to inform and optimise a wind-tunnel campaign, including on-the-fly. Second, considering the vast amount of data that a high-fidelity CFD run and a fully instrumented wind-tunnel test can produce, particularly for unsteady flow simulations, the first objective calls for high parallelisation utilising future computing systems, such as those explored within this CDT.

Go to the EPSRC CDT In Distributed Algorithms website.