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CAD-based Adaptive Parametrisation Framework for Aerodynamic Shape Optimisation

Rejish Jesudasan*[1], Pavanakumar Mohanamuraly[2] and Jens-Dominik Müller[3]

[1] PhD Student, Queen Mary University of London, r.jesudasan@qmul.ac.uk
[2] PhD Student, Queen Mary University of London, p.mohanamuraly@qmul.ac.uk
[3] Queen Mary University of London, j.mueller@qmul.ac.uk

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CAD-based shape optimisation with adjoint CFD has attracted widespread interest in recent years. Most CAD-based shape parametrisation methods use an 'explicit' parametrisation that is manually set-up, e.g. using intuitive engineering design variables. This defines a static design space of all expressible shapes, which is typically too restrictive and impedes the generation of superior designs outside this envelope. The NSPCC framework [1, 2] implicitly derives design variables for shape optimisation from BRep CAD models and perturbs the control points of its NURBS patches. The BRep is typically does not consider shape control, and may be locally too fine or too coarse for shape optimisation.

We present an extension of the NSPCC framework to include adaptive parametrisation where the optimisation begins in a coarser design space and adaptively refines the parametrisation during the optimisation. As a first step, the BRep is re-parametrised using a coarse control net that provides a sufficiently accurate representation of the shape and geometric constraints. Shape optimisation using NSPCC is performed on this shape. Knot insertion into the control net is performed where large adjoint surface sensitivities could not be addressed by the parametrisation and hence remain in the optimised solution. This process is then repeated recursively.

In the final paper performance, efficiency and capabilities of the adaptive NSPCC framework will be discussed and compared to static NSPCC framework. The methodology will be applied to minimising pressure loss of a cooling channel U-bend passage using an in-house flow and AD-derived discrete adjoint solver.

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