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Shape optimisation for linear stability with a RANS base-flow
JACK BREWSTER, MATTHEW JUNIPER, University of Cambridge — A linear stability analysis of a steady flow yields a series of mode shapes and their corresponding growth rates and frequencies. The presence of modes with positive growth rates indicates that the flow will transition to another steady state or develop unsteady behaviour. Targeting the growth rate, we demonstrate shape optimisation for RANS flows. We examine the flow over a cylinder at a Reynolds number of 1000 with the Spalart-Allmaras turbulence model. A linear stability analysis yields a mode shape analogous to the low Reynolds number vortex shedding mode. Through the introduction of an adjoint global mode and an adjoint base-flow we derive the Hadamard form, a surface integral representation of the shape gradient. This gradient information is then used to modify the shape and reduce the growth rate of the mode. The cost of this approach is independent of the number of parameters and equivalent to an additional eigenvalue problem together with a linear flow calculation. In addition to the model problem of flow over a cylinder an industrial application is also presented.

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