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Computational Aerodynamic Shape Optimisation Using a Concept of Control Nodes and Modified Cuckoo Search

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Abstract : This paper outlines the development of an automated aerodynamic optimisation algorithm using a novel method of parameterising a computational mesh by employing user–defined control nodes. The shape boundary movement is coupled to the movement of the novel concept of the control nodes via a quasi-1D-linear deformation. Additionally, a second order smoothing step has been integrated to act on the boundary during the mesh movement based on the change in its second derivative. This allows for both linear and non-linear shape transformations dependent on the preference of the user. The domain mesh movement is then coupled to the shape boundary movement via a Delaunay graph mapping. A Modified Cuckoo Search (MCS) algorithm is used for optimisation within the prescribed design space defined by the allowed range of control node displacement. A finite volume compressible NavierStokes solver is used for aerodynamic modelling to predict aerodynamic design fitness. The resulting coupled algorithm is applied to a range of test cases in two dimensions including the design of a subsonic, transonic and supersonic intake and the optimisation approach is compared with more conventional optimisation strategies. Ultimately, the algorithm is tested on a three dimensional wing optimisation case.

Keywords : mesh movement, aerodynamic shape optimization, cuckoo search, shape parameterisation
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