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FAST OPTIMISATION USING ADJOINT BASED MULTIRESOLUTION APPROACH

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Major limitation in numerical optimisation is computational cost therefore methods for fast optimisation are a subject of extended research. Optimisation is a complex iterative process where acceleration of each element of the algorithm can give significant improvement in total runtime. CFD iterative problems have very strong relation between accuracy of the solution and needed computational time, result with lower accuracy can be obtained with much less effort. This special feature can be used to develop fast optimisation by adjusting accuracy of CFD problem to the current demand of the optimisation algorithm. This is a general concept of one-shot approach introduced by (Ta'assan et al. 1992).

In the present paper the new one-shot approach is proposed where not only the CFD problem convergence level is adjusted according to the optimisation progress (Jaworski et al. 2005), but also resolution of the computational mesh is dynamically modified. The gradient based optimisation is considered where gradient value is estimated using adjoint method which can be also used to estimate solution error and create optimal grids in terms of number of nodes and solution error (D. Venditti et al. 2003).

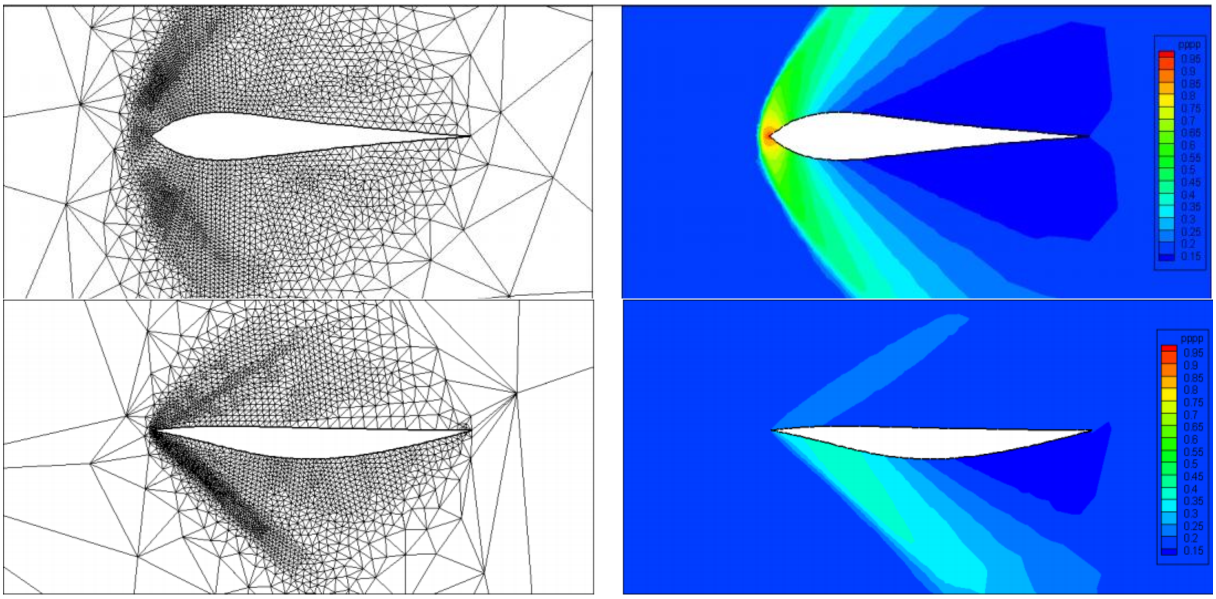

Figure 1. Wave-rider optimisation testcase, $M_\infty= 2.0$. Grid (left) and pressure contours (right) for initial (top) and final design (bottom).

A special parameter is introduced which describes the accuracy required by optimisation algorithm. This parameter is estimated from the current relation between norm of functional gradient |g| and g_{min} and current difference of functional between search directions Δf in relation to Δf_{min}. Constants g_{min} and Δf_{min} are defined by the user. According to the accuracy parameter the error limit of the optimised functional δ_{lim} is found. The obtained error limit δ_{lim} is used as an input to the grid adaptation algorithm which has a task to find grid with lowest number of nodes providing solution with error not larger then δ_{lim}.

The overall benefit of proposed algorithm is examined using optimisation testcase based on simple 2D inviscid simulation of flow around wave-rider body with M_∞= 2.0 (see Fig. 1). The optimisation target is to obtain the shape with lowest body drag and prescribed lift (introduced by penalty term). The present results show that application of goal oriented adaptation together with one-shot algorithm can significantly reduce optimisation time.

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