One-shot robust optimisation with grid adaptation using adjoint sensitivities

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ABSTRACT

Fast optimisation methods for CFD are still a subject of extended research. General concept of one-shot approach introduced by [1] is to scale the functional and gradient accuracy with convergence level of the optimisation. It is assumed that at the beginning of the optimisation high accuracy is not needed while when the process is getting closer to the optimum accuracy may be increased. Lower accuracy of both, the functional and the gradient require less iterations and therefore the overall cost is reduced.

In the present paper we attempt to further reduce the computational cost by adding simultaneous grid adaptation into the process. Already a simple application of grid adaptation in each design step will result in lower cost and better accuracy. However should the discretisation error level be defined by one-shot methodology, even better overall performance can be expected. In this work an extension of one-shot algorithm proposed in [2] is used.

Overall benefit of the algorithm is examined using two different optimisation algorithms, quasi-Newton gradient based L-BFGS-B [3] and Kriging based surrogate model which is used both to reduce the cost of design space exploration and to estimate the robustness of the design. Two optimisation testcases are considered, first based on a simple 2D inviscid flow around wave-rider body with $M_\infty = 2.0$ and second a laminar flow in s-band channel.

Application of adjoint based adaptation with constant target error level already brings significant speedup. The presented results show that application of goal oriented adaptation together with one–shot algorithm can extremely reduce the optimisation time.

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References

[1] S. Ta'asan, G. Kuruvila, M. D. Salas: Aerodynamic Design and Optimisation on One-Shot. *30th Aerospace Science Meeting Exhibit*, AIAA 92-0025, Jan. (1992)

[2] A. Jaworski, P. Cusdin, and J.-D.Müller: Uniformal Converging Simultaneous Time-Stepping Methods For Optimal Design, *Eurogen 2005, Munich*

[3] R. H. Byrd, P. Lu and J. Nocedal: A Limited Memory Algorithm for Bound Constrained Optimization, *SIAM J. on Sc. and Stat. Comp. 16, 5, pp. 1190-1208.(1995)*