Anisotropic grid adaptation using adjoint sensitivities

A. Jaworski*, J. Majewski*, L. Laniewski-Wollk* and J. Rokicki*

*Warsaw University of Technology, Institute of Aeronautics and Applied Mechanics
Nowowiejska 24, 00-665 Warsaw, Poland
(armen, jmajewski, llaniewski, jack)@meil.pw.edu.pl

ABSTRACT

Grid adaptation is present in CFD already for a long time however it is still not a routine technique. Latest works [1,2,3] present efficient adaptation and error estimation for functional outputs, however the implementation is not trivial. This paper shows a relatively straight forward adaptation method using Algorithmic Differentiation tools which allow to compute adjoint sensitivities with moderate implementation effort. The adaptation indicator is based on sensitivity of certain functional output (e.g. drag or lift) **with respect to the movement of each mesh node**,

$$\frac{dL}{d\alpha} = \frac{\partial L}{\partial R}\frac{\partial R}{\partial \alpha}, \qquad R(Q,\alpha) = 0 \tag{1}$$

where L denotes the functional output, Q state variables and α the node movement. It is assumed that uniform distribution of the node sensitivities will result in mesh which will be optimal in terms of functional output error. Obtained sensitivities are used to create an anisotropic metric which is an input to mesh generator. Preliminary results (see fig.1) were obtain using FVM Euler solver based on [4] for lift as functional output.

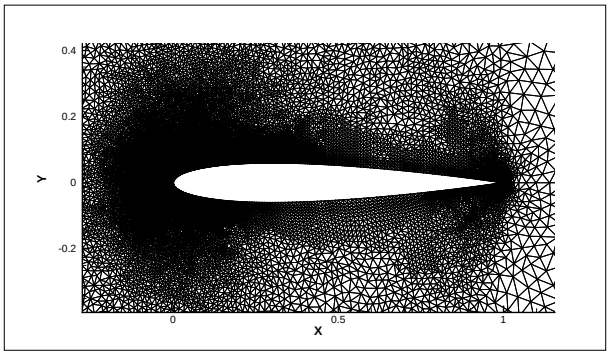

Figure 1: Grid after adaptation, NACA 0012 aerofoil, M=0.43

Acknowledgements: This work is supported by the FP7 FlowHead project (SCP7-GA-2008-218626).

REFERENCES

[1] David A. Venditti and David L. Darmofal, *Grid Adaptation for Functional Outputs: Application to Two-Dimensional Inviscid Flows, J. Comput. Phys. 176, 40-69 (2002)*

[2] Niles A. Pierce, Michael B. Giles, *Adjoint and defect error bounding and correction for functional estimates, J. Comput. Phys. 200, 769-794, (2004)*

[3] Ralf Hartman, *Error Estimation and Adjoint-Based Adaptation in Aerodynamics, ECCOMAS CFD 2006.*

[4] P. Cusind and J.-D. Müller, *Eulsoldo., Technical Report QUB-SAE-03-02, School of Aeronautical Engineering, The Queen's University of Belfast (2003)*