5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

ANISOTROPIC ADAPTATION FOR COMPLEX GEOMETRIES

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Key Words: *Adaptation, Grid Generation, Geometry and Topology Definition.*

ABSTRACT

Grid adaptation is a very powerful tool for optimizing the efficiency of large scale calculations such as the solution of compressible flows. It allows to reduce dramatically the number of unknowns (which is proportional to the number of mesh-points) for a fixed accuracy of the simulation. The number of mesh-points can be further reduced thanks to anisotropic treatment of the adaptation. This allows for efficient capturing of essentialy lower dimensional flow phenomena (shock waves, boundary layers, wakes, wing tip vortices, etc), which are by nature much better represented using directionally distorted mesh cells. The mesh generation algorithm relies in such cases on the anisotropic Delaunay triangulation in the space where the metric tensor is variable and prescribed

In the present approach the anisotropic adaptation is based on remeshing. It means that for every adaptation loop a new grid is generated. The new grid spacing is based on a metric field created by anisotropic error estimator. The tensor error indicator is obatined via estimation of Hessian of the solution (representing the interpolation error of the solution field).

This algorithms was applied for various flow problems including steady and unsteady 3D flow computations. However further elements are needed when considering implementation within general-purpose CFD codes (such as COOLFluiD platform under development in VKI [1]). The main problem which remains is a suffciently general treatment of the curvilinear (nonplanar) boundaries. The difficulty originates from the fact that additional geometry and topology information is needed to correctly reconstruct the boundary during the adaptation step. In the traditional approach the boundary shape remains solely defined by the mesh itself.

In order to provide such information the general purpose GeT library (Geometry-Topology Representation Library) was proposed. This library is able to handle manifolds described by union of NURBS surface patches and contains a collection of data-structures and routines which are able to:

- perform import of geometrical and topological information from the CAD data system (STEP format)
- provide information about topological relations between surface patches and their boundaries

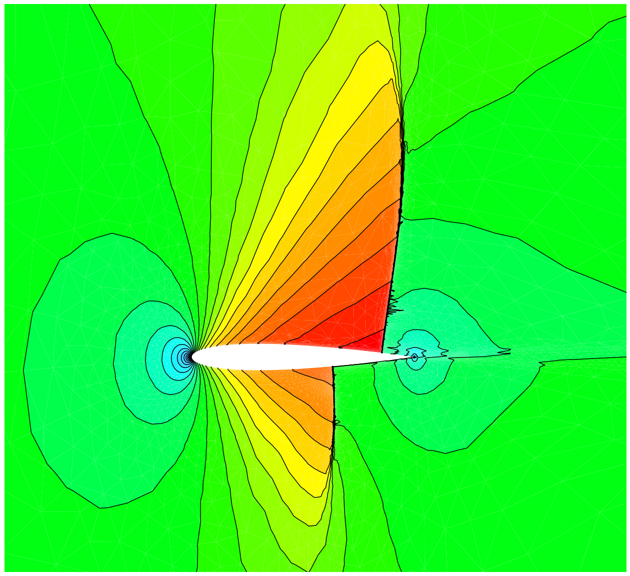

Figure 1: Flow past NACA-0012 ($M_\infty = 0.85$ and $\alpha = 1$) calculated with adaptation using the GeT library for geometry definition

- calculate local mapping from the 2D computational to the 3D surface physical space (and from 1D computational to 2D curvilinear in the planar case)
- evaluate inverse mapping (allowing to perform projection of a point on to the manifold)
- calculate first and second derivatives of the mapping.

The performance of adaptation algorithm coupled with Geometry-Topology Representation Library will be demonstrated for 2D and 3D transonic flows around ONERA M6 wing and ADIGMA BTC0 testcases.

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