Curved meshing for high Reynolds flows solved using high order framework.

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ABSTRACT

In this work, we are interested in the mesh generation problem for simulation of compressible fluids using high order schemes. For this kind of simulation, it is well-known [1] that the subparametric discretization used for geometry's representation (usually piecewise-linear) may lead to errors dominating errors related to the variable field discretization. To solve this problem, we need to generate curved meshes with the same order of the numerical schemes. That means curved elements are essential for approximations of order more than three. As the mesh curvature is a non local property, an element cannot be curved without controlling the neighboring ones.

Our strategy to generate curved meshes [2] is the following: we start with an initial straight mesh and we consider it as an elastic solid. We impose a displacement on the mesh boundaries in order to fit them with the curved geometry. Then we solve linear elasticity equations in order to propagate the boundary curvature inside the mesh. The validity of the final curved volumic mesh is obtained thanks to linear elasticity equation and some properties of Bezier curves/surfaces.

We applied this algorithm to the generation of several simplicial curved meshes both in 2D and 3D. In particular, we are able to generate curved meshes for several turbulent test cases such a M6 wing (Figure 1) and a RAE airfoil.

To illustrate the work, we performed some isogeometric numerical results for compressible fluid dynamics and we compared them with the results provided by the same scheme on a piecewise-linear mesh.

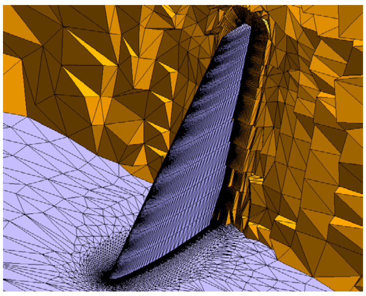

Figure 1: Curved mesh of a M6 Wing

REFERENCES

[1] F. Bassi and S. Rebay. High-order accurate discontinuous finite element solution of the 2D Euler equations. J. Comput. Phys., 138(2):251–285, 1997.
[2] R. Abgrall, C. Dobrzynski, and A. Froehly. A method for computing curved meshes via the linear elasticity analogy, application to fluid dynamics problems. Int J. Numer Meth. Fl., 76(4) :246–266, 2014.