CURVILINEAR MESH GENERATION FOR CFD

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ABSTRACT

There is a growing consensus that state of the art Finite Volume technology requires, and will continue to require too extensive computational resources to provide the necessary resolution, even at the rate that computational power increases. The requirement for high resolution naturally leads us to consider methods which have a higher order of grid convergence than the classical (formal) 2nd order provided by most industrial grade codes. This indicates that higher-order discretization methods will replace at some point the finite volume solvers of today, at least for part of their applications.

The development of high-order numerical technologies for CFD is underway for many years now. For example, Discontinuous Galerkin methods (DGM) have been largely studied in the litterature, initially in a quite theoretical context, and now in the application point of view. In many contributions, it is shown that the accuracy of the method strongly depends of the accuracy of the geometrical discretzation. In other words, the following question is raised: yes we have the high order methods, but how do we get the meshes?

There is indeed orders of magnitude less papers that deals with high order mesh generation than papers that deal, say, with high order DGM. This is indeed awkward because methods like DGM will not percolate in the CFD industry unless high order meshes can be generated with robustness.

This work is about high order curvilinear mesh generation. It does not pretend to give a final answer to the problem but gives some insights on how to generate high order meshes in an automatic manner.

There exists indeed no algorithm that enable to generate high order meshes from scratch. Approaches to generate high-order meshes usually start from standard "straight sided" linear mesh generation followed by assigning high-order geometric shapes to the mesh entities on the curved model boundaries. This presentation principally focuses on surface meshing. We explain in details how mesh entities are curved and what kind of optimization techniques are used for ensuring the validity of the curvilinear meshes. Meshes that are generated have geometric order up to order 4. Some computational results are finally presented that make use of the high order meshes that were generated, essentially the resolution of Navier-Stokes equations with the DGM. All the developments that are going to be presented are readily available in the open source code Gmsh [1].

REFERENCES

[1] C. Geuzaine and J.-F. Remacle. Gmsh: a three-dimensional finite element mesh generator with built-in pre- and post-processing facilities. *International Journal for Numerical Methods in Engineering*, **79**, pp. 1309-1331 (2009)