High order anisotropic adaptive meshing by generalisation of the length distribution tensor paradigm

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ABSTRACT

Anisotropic mesh adaptation techniques have been shown to be very efficient in the last decade with very convincing applications. In modern anisotropic Finite Element, the element stretching can attain very high level as 1 for 1000 to 10000 when capturing boundary layers. The gain in terms of mesh points versus a uniform mesh is thus about 1000 to 10000 and it has been proven by certain applications for which anisotropic mesh adaptation is the only successful known solution. These techniques are well understood and fully developed for P1 simplex element. Until now, the gain in terms of mesh entities was so huge that it allowed compensating low order element. The new available supercomputers showing more than thousand cores enable to run computations on meshes of several million of nodes and it changes this point of view. The over cost of constructing a higher order mesh is gaining in position to be compensated by using high order element and higher convergence.

High order meshes mean building curved element. In this paper, we propose an extension and generalization of the tensor approach and the associated edge based error first introduced in [1]. The novelty of this extension is that it gives a clue for a straightforward construction of curved edges as a consequence of minimizing the interpolation error. We will show that effectively high order approximation give rise to Riemannian geometries in which optimal meshes have curved edges and providing an explicit way of construction.

REFERENCES

[1] T. Coupez, Metric construction by length distribution tensor and edge based error for anisotropic adaptive meshing, J. of Comp. Physics 230: 2391-2405 (2011)