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AN AUTOMATIC MESH COARSENING TECHNIQUE FOR THREE DIMENSIONAL ANISOTROPIC MESHES

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ABSTRACT

Applications of Computational Fluid Dynamics field became increasingly varied and useful in industry: biomechanics, energetics, aerodynamics, etc. These advanced is carried out thanks to the progress and the maturity of the numerical methods. This confidence in the numerical simulation is combined by the processing huge data and consequently an important time computing. To reduce the execution time of the numerical codes, we often apply the following techniques: code optimisation, parallelism and fast algorithms. The first point is a purely data-processing task and it is devoted to the analysis of code (factorization, profiling, debuging, etc). The second point consists to massively employ parallelism by load balacing the workload on several processors and finally to divide the working time on the number of processors used with of course an added time in communication. The third point consists in using the fastest algorithms. Multigrid method is an important example of this category. It allows in the case of elliptic problems to reduce complexity from $\mathcal{O}(N^2 logN)$ to $\mathcal{O}(N)$. The use of fast algorithms as the multigrid method is not always easy within implementation difficulties. We are interested in this work in the implementation of the geometrical multigrid algorithms, based on a sequence of unstructured 3D meshes.

The major difficulty of these algorithms lies in the generation of sequences of meshes which form the multigrid levels. In an industrial context, the mesh of a complex geometry (aircraft in this paper) is unstructured (tetrahedrons) and anisotropic to capture the physical anisotropy (shocks and boundary layers). The aim of this work is to generate a hierarchy of coarse meshes from an anisotropic fine mesh whose aspect ratio exceeds 10^5. The coarse meshes to generate must respect the geometry, preserve gradually the boundary layers structure in the resulting coarse meshes, and to preserve the localization of points (a point remaining on the coarse grid must exist in the fine grid) to facilitate the construction of the transfer operators.

These problems are related to the *generation of controlled anisotropic meshes*. Thus the subject of this paper is to develop an efficient algorithm which prescribes local characteristics of the mesh (size of

the elements, directions of stretching, length of edges...) in the context of a Navier-Stokes problem using restriction-prolongation multi-grid method. The initial mesh is characterized by a layer structure in boundary-layer zones. The study consists in generating a sequence of coarse meshes from the initial fine mesh using a directional coarsening strategy. Such a strategy has to gradually keep the boundary layers structure in the resulting coarse meshes.

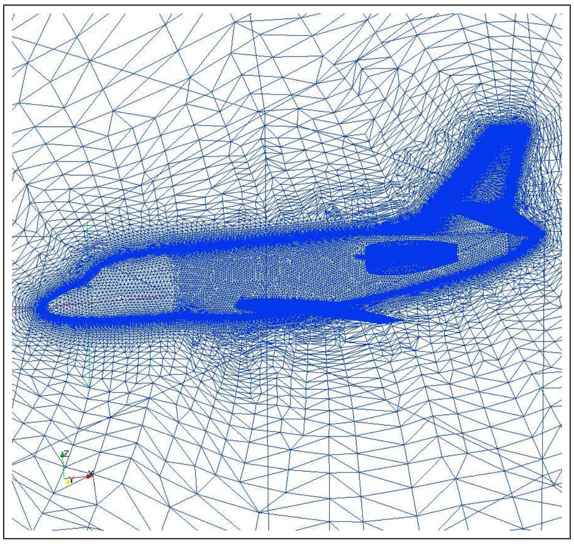

Figure 1: initial mesh

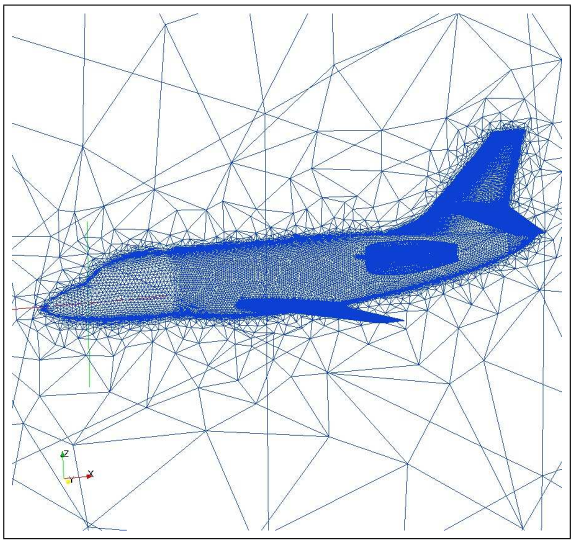

Figure 2: first coarse mesh

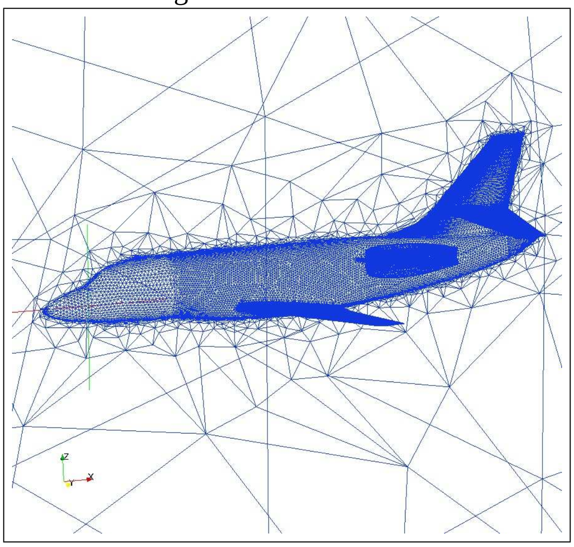

Figure 3: second coarse mesh

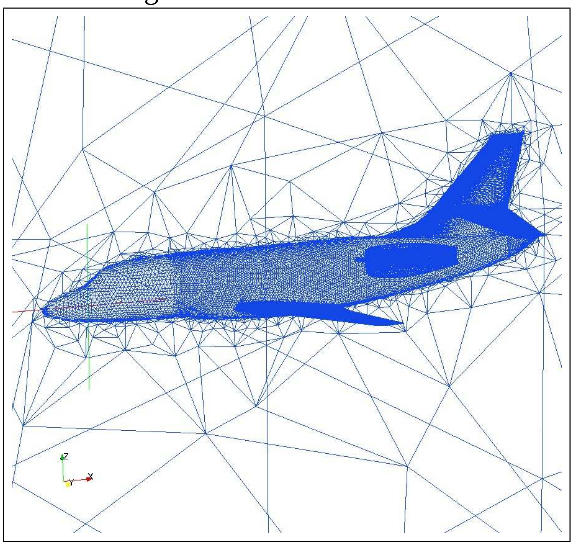

Figure 4: third coarse mesh

Figure 5: Three coarse meshes successively obtained by application of the semi-coarsening algorithm.

REFERENCES

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