8th World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineeering (ECCOMAS 2008)
June 30 –July 4, 2008
Venice, Italy

Blanking Techniques for the Chimera Method

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Key Words : *Chimera, Blanking.*

ABSTRACT

Abstract : In the Chimera method, when a grid meshing a solid body is overset to another grid, points that lie physically in the solid body must be blanked. This article aims at describing the different blanking techniques developped and used at Onera, with emphasis on the recent improvements and enhancements.

Introduction : The Chimera method [1] enables the computation of overset grids. Nevertheless, when two blocks A and B are overset while one of them meshes a solid body (say block A), points of block B that lie in the solid body region must be blanked since they have no physical signification and must not be taken into account by the solver. Around these blanked points, a layer of points is then interpolated to enable transfer of solutions between grids. The blanking region can be defined by the contour of the solid body, but one can also need to enlarge this zone in order to let interpolation occur in less strong gradients region. Also, blanking can be used to transfer a fine grid solution to a coarse one, even if no solid body is present in the region. This paper proposes several methods of blanking, depending on the accuracy of blanking regarding body definition and the required time to compute them.

Blanking techniques : There are two types of blanking techniques : the first one is based on geometric preconditionning, the second one is based on body intersection. In the first category, a "simple" geometric shape is built on the body, this shape is then used as a hole puncher to compute quickly holes in grids. Two shapes are currently available :

- Parallelepiped : the shape is built from the Cartesian bounding box of the solid body.
- Cartesian elements : the shape is made of small adjacent Cartesian boxes. Each box height is adapted to the solid body contour. Depending on the number of Cartesian boxes, the shape is more and more accurate.

In the second category, a XRay technique [2] has been adapted. This method consists first in generating, in a (x,y) plan Cartesian grid, the projection of the surface of the body contour. The second step consists in computing the intersections between the body and rays in z direction originating from each (x_R, y_R) point of the Cartesian grid. A point of an overset grid is then blanked if it is, on the one hand in the neighbourhood of a (x_R, y_R) ray intersecting the body, and on the other hand included between two intersection points.

Recent improvements, enhancements : Improvements and enhancements have been recently added to the previous methods to adapt to new configurations.

- Unclosed body surface : when a body is not a closed surface, previous techniques have been adapted to close it with a plane.
- Blanking criteria : a cell can be blanked if its bounding box intersects the puncher hole shape or only if its center is located inside the shape.
- Rotation : Puncher hole shapes can be rotated to allow a better fit to the body contour.
- Distance (XRay technique) : this technique allows the blanking region to be increased from the body in all directions of a defined distance.
- Perturbation (XRay technique) : in the basic implementation of XRay, if a ray is aligned with a face of the mesh defining the solid body, intersection point can not be unambiguously computed. To avoid those cases, the ray is randomly perturbated of a small value until we get an unambiguous intersection.

Those improvements will be detailed in the final paper.

Examples of applications : Blanking techniques have been applied to a wide range of configurations, from Aircraft, Turbomachinaries to Helicopter. On Fig. 1, the previous different techniques are applied on the dolphin fuselage of Eurocopter. One can note that, as expected, XRay is more accurate than Cartesian elements. This figure also shows an application of XRay with a given delta distance from the solid body.

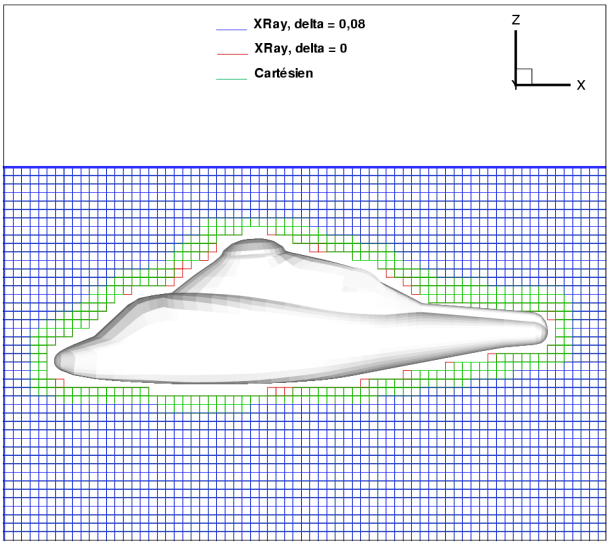

Figure 1: Comparisons between three different blanking techniques : Cartesian elements, XRay, XRay with a delta distance

Conclusion : Several kinds of blanking techniques have been implemented, from current to very accurate methods, from close to far from body and applied to a wide range of applications.

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