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CONFORMAL HEXAHEDRAL MESHES AND ADAPTIVE MESH REFINEMENT

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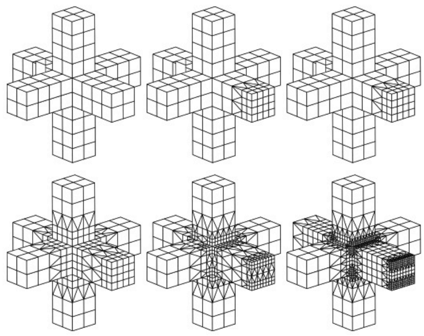
Abstract. In a numerical simulation using the finite element method, the mesh has to be fine enough to guarantee the accuracy of the solution. To achieve this goal, mesh adaptation offers an effective compromise, combining a fine mesh with a low computational cost. With the h-refinement method, some meshes are divided but difficulties occur at the interface between two zones with different levels of refinement, if a conformal mesh is required. That problem is solved either by specific finite elements in the junction or by a specific splitting of these meshes.
If the initial mesh is made of tetrahedra, the splitting of the meshes at the interface produces new tetrahedra. Since the early 90's, this method has been implemented in HOMARD, our software for mesh refinement [1]. But in some numeric simulations, the initial mesh is made of hexahedra because they are more efficient than the tetrahedra. In that case, the transition is not as simple as it is with the tetrahedra: the conformal connection cannot be made with others hexahedra. To solve this problem, we developed a new method: using tetrahedra and pyramids makes possible a conformal connection of the zones of different levels of refinement.
To perform the mesh refinement for conformal hexahedral meshes, first, the error indicator from the computed solution is used to produce a non-conformal mesh [2]. Then, every hexahedron that is at the interface is examined. Counting the number of cut edges, only four situations may occur: 1, 2, 3 or 4. Each of these 4 situations corresponds to a specific pattern for the refinement of the hexahedron.
This conformal refinement method was evaluated with some test cases that use specific finite elements in the transitional zone [3]. The evolution of the refined meshes along the iterations of the adaptation (see figure) ensures the diminution of the global error of the problem.
A test involving an industrial geometry will be presented at the conference.



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[3] S.H. Lo, D. Wu, K.Y. Sze, "Adaptive meshing and analysis using transitional quadrilateral and hexahedral elements"; Finite Elements in Analysis and Design, Vol. 46, pp. 2-16, 2010, doi:10.1016/j.finel.2009.06.010