DATA FITTING AND SHAPE APPROXIMATION WITH CHARMS

B. Zhu and **P. Krysl**

Department of Structural Engineering
University of California, San Diego
La Jolla, CA 92093-0085
pkrysl@ucsd.edu

CHARMS (Conforming Hierarchical Adaptive Refinement Methods) is a recently proposed approach to the construction of adaptive discretization based on the multiresolution equation [1]. Classical hierarchical and so-called quasi-hierarchical approximation spaces may be generated. Both are non-interpolating, and even though partition of unity may be recovered, the actual implementation does not produce it. That poses some interesting challenges.

An effort is under way to apply CHARMS to the *hp*-adaptive FE methods, with CHARMS providing the *h*-type refinement. The non-interpolating character of the CHARMS-refined bases needs to be taken into account when solving three related problems: (i) how to transfer a field from one refined mesh to another, (ii) how to apply inhomogeneous boundary conditions, and (iii) how to adapt the mesh to curved boundaries. All of these could be formulated as interpolation problems, and therefore the question arises: how expensive is it to solve the coupled system of equations to obtain the nodal parameters from the interpolation conditions? We show here that the coupled system of linear equations may be solved with optimal complexity because the approximation bases are endowed with a special structure, which follows from the refinement/unrefinement algorithm that gurantees the linear independence of the basis [1]. For instance for the case of shape approximation with n nodes on the boundary, the n nodal parameters are determined with cost of $O(1)$ per node.

The following example demonstrates all three tasks; The Laplace equation is solved on a circular domain with an all-quadrilateral mesh. The Dirichlet condition is a harmonic function in the angular coordinate. The initial mesh consists of 5 quadrilaterals. With each adaptation of the mesh the solution is transferred from the coarse grid to the finer grid and is then used as the initial guess for the iterative solver. The nodal parameters for the geometry representation are computed from the condition that the boundary nodes should be located on the circular boundary, and the nodal parameters for the sought field are computed to interpolate the Dirichlet condition on the boundary. More details are available at [2].

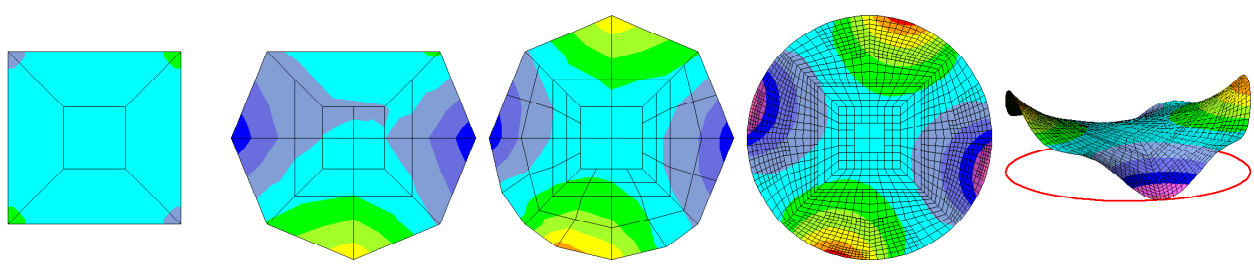

Figure 1: Left to right: initial grid, 3 refined grids, all with solution contours, solution plotted as a raised surface in 3D

References

[1] P. Krysl, E. Grinspun, and P. Schröder. Natural hierarchical refinement for finite element methods. *International Journal for Numerical Methods in Engineering*, 2002. to appear.
[2] P. Krysl. `http://hogwarts.ucsd.edu/~pkrysl/charms.html`