AN ITERATIVE FINITE ELEMENT METHOD FOR BOUNDARY VALUE PROBLEMS IN DOMAINS WITH GEOMETRIC SINGULARITIES: COMPUTING THE COEFFICIENTS OF THE SINGULARITIES

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Many problems in physics and engineering can be modeled mathematically using elliptic boundary value problems. Most of the time the physical domains associated with these problems are non-smooth, in the sense that they may entail corners, edges, cracks, conic vertices, etc. Physical experiments as well as mathematical analysis have shown that the gradient of the solutions (stress or flux) may become unbounded (singularity) in the vicinity of such geometric singularities and near points where there is a change in boundary conditions. Thus the lifespan of the physical system depends highly on its behavior near these geometric singularities.

Standard numerical schemes, for example, finite element, boundary element, finite difference methods, for computing the solution of the boundary value problems may severely lose accuracy when the solution entails singularities.

In this presentation we introduce a new iterative finite element method for accurate computation of the coefficients of the singularities and the solutions for boundary value problems for the Laplace operator in two-dimensional domains with corners and three-dimensional domains with edges. The results are illustrated with numerical examples.

References:

[1] B. Nkemzi and M. Jung. Edge Flux intensity functions for the Laplacian at polyhedral edges. International Journal of Fracture. DOI: 10.1007/s10704-012-9716-0, 2012

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