Parameter free weak boundary and coupling conditions for IGA

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ABSTRACT

Weak Dirichlet-type boundary conditions are especially important in embedded domain methods such as the Finite Cell Method [1]. Well suited are Nitsche-type methods which have been extended to problems of linear elasticity [2] or fluid dynamics. In principle, they consist of two parts. The first part is negative and stems from an suitable Lagrange multiplier. The second part is positive and stems from the minimization of the difference between the primal solution at the boundary minus the imposed values. It is penalty like in nature but acts as a stabilization and ensures coercivity of the system matrix. This penalty part contains a free penalty parameter, which has to be chosen a-priori. Alternatively, the necessary stabilization parameter may also be computed by solving an auxiliary eigenvalue problem [2].

Recently, an attractive alternative was presented [3] in the context of low order methods. It utilizes the same idea of identified Lagrange multipliers as in Nitsche's method, but replaces the penalty terms using the condition that the multiplier is the normal trace of the flux of the unknown in a least squares sense.

We will present an analysis on the performance on this new type of conditions for the Finite Cell Method in the context of p-FEM and Isogeometric Analysis.

Further, we have utilized this method to derive a new formulation for parameter-free coupling of trimmed NURBS. We will show some preliminary results for coupled problems in one and two dimensions for Poisson's equation and for linear elasticity.

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References

[1] J. Parvizian, A. Düster, E. Rank, Finite cell method, h- and p-extension for embedded domain problems in solid mechanics. *Computational Mechanics*, **41**, 121-133, 2007.

[2] M. Ruess, D. Schillinger, Y. Bazilevs, V. Varduhn, E. Rank, Weakly enforced essential boundary conditions for NURBS embedded and trimmed NURBS geometries on the basis of the Finite Cell Method. *International Journal for Numerical Methods in Engineering*, submitted, 2012.

[3] J. Baiges, R. Codina, F. Henke, S. Shahmiri, W.A. Wall, A symmetric method for weakly imposing Dirichlet boundary conditions in embedded finite element meshes. *International Journal for Numerical Methods in Engineering*, **90**, 636-658, 2012.