On the effect of recovery techniques for error estimation in contact problems with the Cartesian grid Finite Element Method (cgFEM)

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ABSTRACT

The Cartesian grid Finite Element Method (cgFEM) [1] is a Finite Element (FE) problem solving technique based on the use of Cartesian meshes independent of the geometry. Among the advantages of this methodology are the automatic and efficient creation of FE models from medical images and the possibility of considering the exact geometry from the NURBS definitions of CAD models. Resolution of 3D contact problems has been recently implemented within this technique, enabling personalized simulations of prosthetic-living tissue interaction.
The cgFEM uses the Zienkiewicz and Zhu error estimator [2] to guide the h-adaptive mesh refinement procedure. In the present work we study the behavior of this estimator in the framework of contact problems using different techniques to obtain the smoothed stress field. First, we use the Superconvergent Patch Recovery (SPR) technique, proposed by Zienkiewicz and Zhu [3]. Next, modifications of this technique are considered: the first includes the internal and Neumann boundary equilibrium in the SPR minimization problem [4], and the second and more recent one also includes the balance over the contact boundary. The results obtained show that the inclusion of the contact balance in the SPR problem improves the quality of the smoothed stress field, and with this, better error estimates are obtained, especially in the contact area.
Keywords: cgFEM, Superconvergent Patch Recovery (SPR), contact, recovery, Cartesian grids

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