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SHAPE SENSITIVITY ANALYSIS INCLUDING QUALITY CONTROL WITH CARTESIAN FINITE ELEMENT MESHES

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Abstract. The gradient-based optimization methods used for optimization of structural components require that the information of the gradients (sensitivity) of the magnitudes of interest is calculated with sufficient accuracy. The aim of this paper is to present a module for calculation of shape sensitivities with geometric representation by NURBS (Non-Uniform Rational B-Splines) for a program created to analyze 2-D linear elasticity problems, solved by FEM using cartesian grids independent of the geometry, CG-FEM.

First, it has been implemented the ability to define the geometry using NURBS, which have become in recent years in the most used geometric technology in the field of engineering design. In order to be able to represent exact geometries, a scheme based on matrix representation of this type of curve and proper integration is proposed. Moreover, the procedures for shape sensitivities calculation, for standard FEM, have been adapted to an environment based on cartesian meshes independent of geometry, which implies, for instance, a special treatment of the elements trimmed by the boundary and the implementation of new efficient methods of velocity field generation, which is a crucial step in this kind of analysis.

Secondly, an error estimator, as an extension of the error estimator in energy norm developed by Zienkiewicz and Zhu, has been proposed for its application to the estimation of the discretization error arising from shape sensitivity analysis in the context of cartesian grids.

The results will show how using NURBS curves involves significant decrease of geometrical error during FE calculation, and that the calculation module implemented is able to efficiently provide accurate results in sensitivity analysis thanks to the use of the CG-FEM technology.

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