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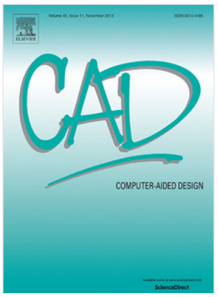

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A. Johnen, C. Geuzaine, T. Toulorge, J.-F. Remacle

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Efficient computation of the minimum of shape quality measures on curvilinear finite elements

A. Johnen[a,b], C. Geuzaine[a], T. Toulorge[c], J.-F. Remacle[b]

[a] *Université de Liège, Department of Electrical Engineering and Computer Science, Grande Traverse 10, 4000 Liege, Belgium*
[b] *Université catholique de Louvain, Institute of Mechanics, Materials and Civil Engineering (iMMC), Avenue Georges Lemaitre 4, 1348 Louvain-la-Neuve, Belgium*
[c] *Cemef - Mines ParisTech, rue Claude Daunesse 1, 06904 Sophia-Antipolis, France*

Abstract

We present a method for computing robust shape quality measures defined for finite elements of any order and any type, including curved pyramids. The measures are heuristically defined as the minimum of the pointwise quality of curved elements. Three pointwise qualities are considered: the *ICN* that is related to the conditioning of the stiffness matrix for straight-sided simplicial elements, the *scaled Jacobian* that is defined for quadrangles and hexahedra, and a new shape quality that is defined for triangles and tetrahedra. The computation of the minimum of the pointwise qualities is based on previous work presented by Johnen et al. (2013, 2015) [1, 2] and is very efficient. The key feature is to expand polynomial quantities into Bézier bases which allows to compute sharp bounds on the minimum of the pointwise quality measures.

Keywords: finite element method, finite element mesh, quality of curved elements, Bézier basis

1. Introduction

With recent developments in the field of high-order finite element methods [3], such as discontinuous Galerkin [4] or spectral [5, 6] methods, there is a renewed interest for high-order (curved) mesh generation. The classical finite element method, a.k.a. the h-version, uses linear elements to discretize the geometry and the mesh is refined in order to increase the accuracy of the solution. It has been established that the p-version of the finite element,