Accepted Manuscript

Spectral approximation properties of isogeometric analysis with variable continuity

Vladimir Puzyrev, Quanling Deng, Victor Calo

PII: S0045-7825(18)30049-5
DOI: https://doi.org/10.1016/j.cma.2018.01.042
Reference: CMA 11762

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date : 27 September 2017
Revised date : 30 December 2017
Accepted date : 20 January 2018

Please cite this article as: V. Puzyrev, Q. Deng, V. Calo, Spectral approximation properties of isogeometric analysis with variable continuity, *Comput. Methods Appl. Mech. Engrg.* (2018), https://doi.org/10.1016/j.cma.2018.01.042

Spectral approximation properties of isogeometric analysis with variable continuity

Vladimir Puzyrev[a,b,*], Quanling Deng[a,b], Victor Calo[a,b,c]

[a] *Curtin Institute for Computation, Curtin University, Kent Street, Bentley, Perth, WA 6102, Australia*
[b] *Department of Applied Geology, Curtin University, Kent Street, Bentley, Perth, WA 6102, Australia*
[c] *Mineral Resources, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Kensington, Perth, WA 6152, Australia*

Abstract

We study the spectral approximation properties of isogeometric analysis with local continuity reduction of the basis. Such continuity reduction results in a decrement in the interconnection between the degrees of freedom of the mesh, which allows for large computational savings during the solution of the resulting linear system. The continuity reduction results in extra degrees of freedom that modify the approximation properties of the method. The convergence rate of such refined isogeometric analysis is equivalent to that of the maximum continuity basis. We show how the breaks in continuity and inhomogeneity of the basis lead to artefacts in the frequency spectra, such as stopping bands and outliers, and present a unified description of these effects in finite element method, isogeometric analysis, and refined isogeometric analysis. Accuracy of the refined isogeometric analysis approximations can be improved by using non-standard quadrature rules. In particular, optimal quadrature rules lead to large reductions in the eigenvalue errors and yield two extra orders of convergence, as it occurs in standard isogeometric analysis.

Keywords: Isogeometric analysis, Spectral approximations, High order, Refinement, Continuity, Eigenvalue problem

1. Introduction

Isogeometric analysis (IGA) is a numerical technique for approximating the solutions of partial differential equations, which was introduced in 2005 [26] and received significant attention since then [3, 5, 9, 13–15, 25, 27–29]. Spectrum analysis of isogeometric discretizations shows that this method is more accurate compared to the classical finite element analysis (FEA) for a fixed number of degrees of freedom [14, 27, 28]. Isogeometric analysis uses as basis functions those employed in computer aided design (CAD) systems that can represent exactly many complex geometries relevant in engineering applications. The isogeometric framework allows higher continuity across element interfaces

*Corresponding author
Email addresses: vladimir.puzyrev@gmail.com (Vladimir Puzyrev), qdeng12@gmail.com (Quanling Deng), vmcalo@gmail.com (Victor Calo)