REFINED ISOGEOMETRIC ANALYSIS (RIGA) FOR ELECTROMAGNETICS

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ABSTRACT. Refined Isogeometric Analysis (rIGA) is a computational method developed to solve numerical problems governed by partial differential equations (PDEs). Starting from a highly continuous Isogeometric Analysis (IGA) discretization, this method reduces the continuity over certain hyperplanes, which act as separators during the elimination of the degrees of freedom (DoF). rIGA dramatically reduces the computational time employed to approximate the PDEs solution using direct solvers and simultaneously improves the best approximation error. When using rIGA, the total computational time required to solve a Laplace based problem in 2D or 3D decreases by a factor of $\mathcal{O}(p^2)$ (with p being the polynomial order) with respect to the IGA (with maximum continuity) counterpart [1, 2, 3], without losing accuracy.

In this work, we numerically analyze the main features and limitations of rIGA to solve electromagnetic problems. We apply rIGA method to approximate the 2D electromagnetic fields that result from imposing a magnetic dipole source. We use a spline-based generalization of the 2D Ndelec finite element spaces previously introduced by Buffa et al. in [4] to set the curl-conforming space discretization (Maxwell problem).

Our theoretical estimates show that rIGA delivers a reduction in the computational cost when solving the electromagnetic problems that become $\mathcal{O}(p^2)$ for sufficiently large grids (asymptotic regime). Numerical results confirm these theoretical estimates. Besides, this method provides better accuracy than traditional C^{p-1} IGA.

For future work, we plan to apply rIGA to solve resistivity well logging problems in three dimensions. In these problems, rapid solutions of Maxwell's equations are decisive to correct the well trajectory in real time for geosteering purposes.

Keywords: Isogemetric Analisys, refined Isogeometric Analysis, Direct Solvers, Electromagnetism problems, Continuity reduction

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