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Superconvergence analysis of second and third order rectangular edge elements with applications to Maxwell's equations *

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Abstract. Superconvergence for the second and third order edge elements is investigated on nonuniform rectangular meshes. First, we develop the explicit expression for the Nédélec interpolation based on the hierarchical basis functions. Then we prove that the pointwise interpolation error estimates are one order higher at element Gauss points than the standard analysis can provide. Using the superconvergence at Gauss points, we establish the discrete l^2 norm superconvergence for the solution of Maxwell's equations solved by both the second and third order rectangular edge elements. Numerical results justifying our theoretical analysis are presented.

Key words. Edge elements; Maxwell's equations; superconvergence; finite element method.

1 Introduction

Superconvergence of finite element approximations has been an active research topic starting from 1970's. Many interesting results have been obtained for various partial differential equations (cf., papers [4, 5, 21, 26, 33, 35], books [3, 8, 24, 32], special issues [18, 34] and references cited therein). Recently, there is a growing interest in studying the superconvergence of discontinuous Galerkin methods, e.g., [1, 7, 11, 12].

In regard to edge elements and their applications to Maxwell's equations, the superconvergence results are quite limited. The first superconvergence result is due to Monk's 1994 work [27] for the magnetostatic problem and time-dependent Maxwell system. One order higher convergence in special discrete norms than the standard norms is proved for nonuniform tensor product grids. Since then, further studies have been made for triangular elements by Brandts [6], and parallepiped elements by Lin and his coworkers for Maxwell's

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