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Virtual element method for solving boundary integral equations of electromagnetic scattering at a perfectly conducting body

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For the analysis of electromagnetic scattering phenomena in homogeneous media, the method of boundary elements, relying on a finite-element-type approximation of boundary integral equations, has proven efficient in solving the time-harmonic Maxwell equations. However, in a constrained context, featuring a rise in wave frequency, geometric complexity and diversity of 3D environments, the lack of flexibility of such classical numerical schemes in the design phase of the mesh is likely to limit their performance. Indeed, the conformity and the maximum local deformation required within the mesh between elements can significally increase the size of the resulting linear system as well as deteriorate the quality of numerical results. In this talk, we consider the electric field integral equation of electromagnetic scattering [1] at a perfectly conducting body in 3D. Our focus is on the discretization of this problem by means of the most recent virtual element method [2] in order to overcome the limitation of classical finite element approaches by lifting the aforementioned mesh constraints. The virtual element approximation can handle polygonal/polyhedral meshes, principally because of the way the method assembles the global linear system: the explicit knowledge of the non-polynomial basis functions on each mesh element is not needed, yet only the related degrees of freedom are used for computing the local bilinear form. We study here how to adapt this general idea to the Maxwell single layer boundary operator within the above integral equation formulation. For the discretization, we consider the use of the serendipity variant of H(div)-conforming virtual element spaces [3] (at lowest order) on a polygonal mesh made of triangular-shape elements. We analyze the mathematical properties of these virtual elements through numerical experiments on non-conforming triangulations and show a direct comparison of performance with their finite-element analogous, i.e. the Raviart-Thomas elements, on a conforming mesh.

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