A NONCONFORMING TREFFTZ VIRTUAL ELEMENT METHOD FOR THE FLUID-FLUID INTERFACE PROBLEM

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Abstract. We introduce a novel nonconforming Trefftz virtual element method based on general polygonal meshes for the approximation of solutions to a 2D fluid-fluid interface problem, i.e., to a Helmholtz problem with piecewise constant wave number. The local discrete spaces consist of plane and evanescent waves, plus additional functions defined implicitly as solutions to suitable local auxiliary Helmholtz problems. The degrees of freedom are associated with the mesh edges, and the global space is built in a nonconforming fashion (à la Crouzeix-Raviart). We present a variety of numerical experiments, including the h-, the p-, and the hp-versions of the method, employing both isotropic and anisotropic mesh refinements. The reason why the proposed approach can be considered as a very effective substitute of other well-established technologies tailored for the approximation of solutions to Helmholtz type problems, such as the plane wave discontinuous Galerkin method or the ultra-weak variational formulation, is that an orthogonalization-and-filtering technique, not applicable to the best of our knowledge in the discontinuous Galerkin setting, renders the nonconforming Trefftz virtual element approach particularly robust. More precisely, by eliminating "redundant" basis functions, such technique leads to a significant reduction of the number of the degrees of freedom and of the condition number of the system stemming from the method; in some occurrences, the method seems even to converge whilst keeping the dimension of the space almost fixed!

Keywords: nonconforming virtual element methods, Trefftz methods, Helmholtz problem, piecewise constant wave number, plane and evanescent waves, polygonal meshes

Mathematics Subject Classifications (2010): 35J05, 65N12, 65N30

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