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RELATION BETWEEN MIMETIC FINITE DIFFERENCE SCHEMES AND FINITE ELEMENT METHODS FOR SOME MODEL PROBLEMS IN H(CURL) AND H(DIV)

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In this work, we consider mimetic finite difference discretizations of divergence, gradient and curl operators. These discrete grid operators satisfy compatibility conditions which naturally connect grad, div and curl operators on the continuous level. Our aim is to show how such mimetic finite difference schemes can be derived using standard finite element spaces in H(curl) and H(div). Once obtained this relation, we can use the finite element framework to prove the convergence of the mimetic finite difference schemes, and to construct efficient multigrid methods for the solution of elliptic partial differential equations on H(curl) and H(div), by using these methods. In this way, we propose and analyze, via the local Fourier analysis framework, robust geometric multigrid algorithms for such problems on simplicial/Voronoi grids in a matrix-free fashion, which result in fast solvers with low memory requirements. Finally, we demonstrate the robustness and efficiency of such methods by presenting several numerical tests.