A 3D face interpolated discretisation method for simulating highly anisotropic diffusive processes on general hexahedral meshes

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Abstract

In this talk, a new 3D numerical discretisation method for solving the anisotropic, steady-state diffusion problem is presented. The scheme is constructed on general hexahedral meshes using the geometrical properties of the cells. Indeed, each cell provides a local basis formed using the centres of its lateral faces. The discrete cell gradient approximation is then obtained by using three discrete directional derivatives resolved in terms of this basis, and by invoking the consistent relationships between opposite faces of the same cell. The face degrees of freedom are interpolated to reduce the complexity of the numerical scheme, resulting in the main unknowns being entirely nodal based. The scheme is unconditionally coercive and admits a unique solution. Various numerical experiments are performed to highlight the accuracy and the robustness of the method with respect to the mesh and anisotropy. An important outcome is that second order convergence is observed for all problems considered, even for highly deformed meshes.

Keywords: Diffusive equations, hexahedral meshes, 3D discrete gradient, anisotropy, second order accuracy.