Construction of $H_{\text{div}}$ finite element spaces for three-dimensional geometries


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ABSTRACT

Having in mind applications to the simulation of porous media flows, a classical approach is the use of mixed formulations [1], which are characterized by simultaneous calculations of pressure and velocity fields. Approximation spaces suitable for the velocity variable are of $H_{\text{div}}$ type, which are formed by vectorial functions not necessarily continuous, but having continuous normal components at the interfaces between elements of the domain partition. This property is crucial for mass conservation, a fundamental property for this kind of application.

This work focuses on the construction of new $H_{\text{div}}$ finite element spaces for three-dimensional curved meshes formed by tetrahedral, hexahedral or prismatic elements. The adopted methodology for the construction of $H_{\text{div}}$ bases consists in using hierarchical scalar $H^k$ bases multiplied by vectors that are properly chosen over the geometrical elements. This methodology has already been successfully applied to bi-dimensional triangular and quadrilateral partitions composed by elements whose boundaries are rectilinear by parts [2].

The implementation and verification of the proposed $H_{\text{div}}$ spaces are performed in the scientific computation environment named NeoPZ (http://code.google.com/p/neopz). This is a finite element computing library based on object-oriented programming. The required $H^k$ bases, for a variety of three-dimensional geometries, and bi-dimensional $H_{\text{div}}$ bases are already implemented in NeoPZ. Verification results are shown for curved triangular, quadrilateral, and hexahedral meshes.

REFERENCES
