A Hybrid High-Order Finite Element Approximation for the Optimal Control Problem of a Class of Quasilinear Problems

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Project Description

We focus on the Hybrid High-Order (HHO) finite element approximation for the distributed optimal control problem governed by a class of quasilinear partial differential equations (PDEs). We first design an HHO approximation for the problem and then analyze the stability and convergence of the discrete solution by a priori error analysis. We minimize a cost functional related to a desired state and control, subject to a class of quasilinear PDEs that model a stationary heat distribution of a metal body. The problem is defined on a polytopal domain. We consider polyhedral meshes to handle the complicated geometry of the domain. The design involves a local reconstruction operator that can be solved easily by a simple matrix inversion. The global assembly of this finite element technique is based on static condensation that reduces the global degrees of freedom. This makes the solution procedure robust and efficient. The HHO method is applicable for a low-order as well as a high-order polynomial approximation. First, we establish the error estimations for the discrete state and adjoint variables in the energy norm without control discretization. Then we consider a fully discrete optimality system and derive L^2-estimation for the discrete control variable. To handle the nonlinearity, we consider a linearized problem. The wellposedness of the discrete linearized problem will be used to propose a nonlinear map whose fixed point will be the solution of the discrete problem. We study the existence and local uniqueness of the discrete solution using a fixed point argument. We perform numerical tests in MATLAB for the validation of the theoretical results.

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