

A Scalable MPI hp-Adaptive Finite Element Software Library for Complex Multiphysics Applications

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Abstract: The project builds on three decades of work on hp-adaptive Finite Element (FE) methods and software, and the most recent (fifth) version of three-dimensional hp3D code incorporating the most recent advances in the field. The current code supports solution of coupled problems and discretization with $H(\text{grad})$ -, $H(\text{curl})$ -, $H(\text{div})$ -, and L_2 -conforming finite elements necessary for complex multiphysics models.

The code has been designed to support standard Galerkin methods but in the last four years has served as a main platform for research on the Discontinuous Petrov Galerkin (DPG) Method with Optimal Test Functions. Through the “on fly” computation of (problem dependent) optimal test functions, the DPG method guarantees automatically a stable discretization for any well posed (linear) variational problem and offers a built-in a-posteriori residual error estimation.

Long-term goal: To develop an MPI/openMP version of an existing openMP hp-adaptive Finite Element (FE) software, document it, and put the updated versions into public domain under BSD License. We have already started the work on MPI implementation of the code within our current Air-Force project on modeling optical amplifiers (lasers). The work constitutes a core of the Ph.D. work of Stefan Henneking. We have also secured an additional funding from Sandia.

