Solving Nonlinear Finite Element Problems in Elasticity

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Finite element methods (FEM) for displacement problems in hyperelasticity lead to systems of nonlinear equations. These equations are usually solved with Newton's method or a related method. The convergence of Newton's method depends heavily on the proximity of the initial guess to the numerical solution. Load step methods overcome problems with divergence by applying the load in increments, leading to a sequence of sub-problems with initial guesses closer to the numerical solution of each sub-problem, supporting the convergence. The downside of this approach is the significant increase in computing time. Based on a benchmark problem in high-order FEM, we extend traditional load step methods to a new approach exploiting the hierarchical structure of the problem and saving about 50% of computation time (vs. benchmark).