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A Mixed Finite Element Formulation for Arbitrary Element Geometries and Nearly-Incompressible Finite Elasticity

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In this work, the displacement-based scaled-boundary finite element method (SBFEM) is extended to a mixed displacement-pressure formulation for both the geometrically and materially nonlinear analysis of nearly-incompressible solids. The displacements and pressures are both parameterized by a scaled-boundary approach, for which an interpolation in scaling direction is used. Here, higher-order interpolation functions may be employed. It is shown that by introducing the pressure as a field variable, the occurence of volumetric locking is no longer dependent on the location of the scaling center. This allows for a scaling center at arbitrary locations, both inside and outside the element domain. Other than that, the formulation is valid for non-star-convex element geometries. Numerical examples show that the method is capable of alleviating volumetric locking for arbitrary polygonal meshes and is beneficial in comparison to the displacement-based method when it comes to modeling nearly-incompressible materials.

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