The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

A discontinuous Petrov-Galerkin method for elasticity problems with non-linear decomposition of the elastic energy density function

Jacob E. Salazar Solano [1] and Leszek Demkowicz [2]

[1] Oden Institute for Computational Engineering and Sciences, University of Texas at Austin, Austin, Texas, USA 78712-1229, jsalazar@oden.utexas.edu
[2] Oden Institute for Computational Engineering and Sciences, University of Texas at Austin, Austin, Texas USA, 78712-1229, leszek@oden.utexas.edu

Keywords: *Non-linear elasticity, Finite elements, Discontinuous Petrov-Galerkin, Optimal test functions.*

We present the solution of non-linear elasticity problems with a scheme belonging to the family of Petrov-Galerkin methods with optimal test functions, proposed by Demkowicz and Gopalakrishnan [3]. Such a family is characterized by its flexibility and stability properties, verified with applications to a wide range of problems, Maxwell equations[1], linear elasticity [4] and convection-dominated diffusion [2], to mention a few. However the applications to non-linear problems are more scarce in the literature; particularly for elasticity problems, the only prior work known to us [5] focuses on a source of non-linearity different than ours.

Our ultimate goal is to take advantage of the stability and adaptivity capabilities of the aforementioned family, for solving phase-field models for crack propagation. This motivates the present work, which tackles the initial challenge of solving the elasticity problem for a non-linear decomposition of the elastic energy density function. We present a linearization scheme and numerical examples in 2D case.

REFERENCES

[1] C. Carstensen, L. Demkowicz, and J. Gopalakrishnan. Breaking spaces and forms for the DPG method and applications including maxwell equations. *Computers & Mathematics with Applications*, 72(3):494–522, 2016.

[2] J. L. Chan. A DPG method for convection-diffusion problems. 2013.

[3] L. Demkowicz and J. Gopalakrishnan. A class of discontinuous Petrov–Galerkin methods. ii. optimal test functions. *Numerical Methods for Partial Differential Equations*, 27(1):70–105, 2011.

[4] B. Keith, F. Fuentes, and L. Demkowicz. The DPG methodology applied to different variational formulations of linear elasticity. *Computer Methods in Applied Mechanics and Engineering*, 309:579–609, 2016.

[5] J. D. Mora Paz et al. *PolyDPG: a discontinuous Petrov-Galerkin methodology for polytopal meshes with applications to elasticity.* PhD thesis, 2020.