Enriched finite element modeling of interface problems

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The finite element method (FEM) is the standard procedure for solving problems in solid mechanics. Modeling problems with complex or evolving interfaces, however, rapidly exposes the main pitfall of the method: Creating finite element (FE) meshes that align to interfaces or cracks is a tedious and error-prone process that can take a considerable amount of time in a simulation. Enriched finite element formulations overcome this drawback in an elegant manner by decoupling the finite element discretization from the discontinuities. This is accomplished by using *a priori* knowledge about the solution in the form of enrichment functions that recover the accuracy otherwise lost by using a mesh that does not align with interfaces. Enriched FEM can therefore be seen a generalization of FEM that makes use of non-polynomial bases.

This presentation delves into the computational modeling of problems containing interfaces. It is shown that enriched FEM can be used to solve problems with complex morphologies by using simple structured FE discretizations. As shown in Figure 1, particular emphasis will be placed in the analysis of discontinuities, including multiphase (composite) materials [1], fracture [2, 4], and immersed boundary problems [3]. We also discuss the application of enriched FEM to other interface problems, including contact mechanics and topology optimization of metamaterials.

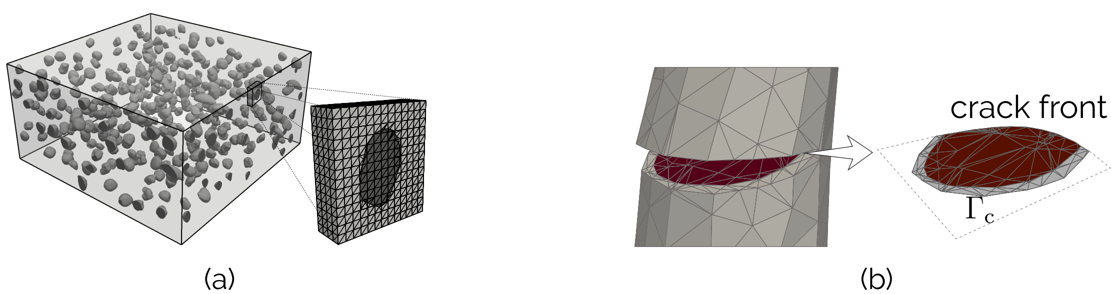

Figure 1: Enriched FEM applied to (a) composites; and (b) fracture.

References

[1] A. M. Aragón, B. Liang, H. Ahmadian, and S. Soghrati. "On the stability and interpolating properties of the Hierarchical Interface-enriched Finite Element Method". In: *Comput Methods in Appl Mech Eng* (2020, In Press).

[2] A. M. Aragón and A. Simone. "The Discontinuity-Enriched Finite Element Method". In: *Int J Numer Meth Eng* 112.11 (2017), pp. 1589–1613.

[3] S. J. van den Boom, J. Zhang, F. van Keulen, and A. M. Aragón. "A Stable Interface-Enriched Formulation for Immersed Domains with Strong Enforcement of Essential Boundary Conditions". In: *Int J Numer Meth Eng* (2019).

[4] J. Zhang, S. J. van den Boom, F. van Keulen, and A. M. Aragón. "A stable discontinuity-enriched finite element method for 3-D problems containing weak and strong discontinuities". In: *Comput Methods in Appl Mech Eng* 355 (2019), pp. 1097–1123.