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Extra-dof-free and linearly independent enrichments in GFEM/XFEM

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A GFEM without extra dof has been developed. The new GFEM inherits the excellent accuracy and convergence properties of the existing GFEM and additionally offers excellent stability. The new method has no extra nodal dof, is free of linear dependence and is significantly good conditioned. The excellent stability and the extra-dof-free feature would be greatly rewarded in large-scale problems and applications to dynamic analyses (the mass matrix now can be defined in a usual way).

The new GFEM interpolates as long as the local approximation at least interpolates at the patch star, no matter that the local approximation is in nature an interpolation or an approximation. The RBF and the Selectively Interpolating MLS/LS have been developed to construct the extra-dof-free local approximation on an unstructured mesh of any dimension, without losing the Kronecker delta property.

A simple approach is proposed to recover linear consistency on the blending elements in the adaptive implementation. Numerical tests show the excellent performance of the approach—the adaptive GFEM offers a clean and smooth transition from the FEM to the GFEM approximation without complicating implementation.

In summary, although much remains to be investigated, we believe that the potential of the new GFEM developed herein is very attractive.

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