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Hierarchical derivation of shape functions and stiffness matrix calculation of EFG meshless methods

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Meshless methods have shown increased accuracy and better convergence rates compared to other well-known simulations methods in a great variety of computational mechanics problems. However, due to their increased computational cost in the derivation of the shape functions in order to formulate the stiffness matrix as well as in the solution of the resulting equations their application in real-world problems is rather limited. These shortcomings are further aggregated in adaptivity analysis, when new nodes are inserted at each step, where the updated shape function construction requires a significant amount of computational effort. In this paper, we propose a hierarchical formulation in the context of an h-type refinement scheme, dealing with the problem of adding new nodes and subsequently re-calculating the influenced moment matrices that are necessary for obtaining the shape functions and their derivatives and subsequently for the construction of the stiffness matrix. A novel approach is proposed for the implementation of an h-refinement scheme which produces hierarchically refined stiffness matrices by adding only the additional node contributions to each shape function field.

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