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Efficient and Accurate Numerical Integration for High Order Immersed Boundary Methods

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The Finite Cell Method (FCM) is an embedded domain approach combined with high order finite elements. An important problem concerning the efficiency and accuracy of FCM especially in case of higher order shape functions is the numerical integration of cut boundary cells.

Several approaches have been suggested to improve the performance and accuracy of the numerical quadrature. For XFEM applications, it was shown that nearly optimal convergence rates can be achieved in combination with NURBS-enhanced finite elements [1]. The treatment of cut elements in the context of Isogeometric Analysis combined with trimmed CAD surfaces was studied in [2]. For the Finite Cell Method, the triangulation of the cut cells and its influence on the convergence behavior was discussed in [3].

In this presentation we introduce a combination of quadtree based integration and the blending function approach being similar to recent studies of Legrain [1]. We extend these concepts concerning algorithmic simplicity and generality, and demonstrate robustness even for close-to-degenerate cases. We will show for 2D numerical examples that optimal convergence rates can be obtained with a nearly minimal number of integration points. Finally, a possible extension of the algorithm to 3D cases will be shown on the conceptional level.

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