Fast Formation and Assembly of Matrices in Isogeometric Analysis

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ABSTRACT

Recently, a new formation and assembly strategy was proposed in [1], which resulted in significant speedups in the formation and assembly time of the Galerkin mass matrix in isogeometric analysis. The strategy relies on three key ingredients: (1) assembly row by row, instead of element by element; and an efficient formation strategy based on (2) sum factorization and (3) weighted quadrature, that is applied to each specific row of the matrix. Compared to traditional element procedures applied to three dimensional problems, the computational complexity is lowered from $O(p^9)$ per degree of freedom to $O(p^4)$, where p is the order of polynomials. Consequently, this type of formation and assembly scales favorably with polynomial degree, which opens the way for high order isogeometric analysis employing k-refinement, that is, use of maximally smooth, higher order splines. In this talk we discuss various important details for the practical implementation of the weighted quadrature formation strategy proposed in [1,2,3]. Specifically, we discuss the weighted quadrature scheme to accurately integrate the elements of the stiffness matrix in linear elasticity [2] and we discuss efficient assembly also in the BEM case [3] where singular integrals appear.
We show that the accuracy of full Gauss quadrature is maintained while the computational burden of forming the matrix equations is significantly reduced.
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REFERENCES

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