Fast Formation And Assembly in Isogeometric Analysis With Applications In Linear Elasticity

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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 two key ideas: 1) assembly row by row, instead of element by element; and 2) an efficient formation strategy based on weighted quadrature and sum factorization that is applied to each specific row of the matrix. The resulting computational effort is proportional to the number of degrees of freedom of the trial space. Consequently, this type of formation and assembly scales favorably with polynomial degree, which opens the way for high order isogeometric analysis employing k-refinement. In this work we discuss various important details for the practical implementation of the weighted row-wise formation strategy proposed in [1]. Specifically, we extend the weighted quadrature scheme to accurately integrate the elements of the stiffness matrix in linear elasticity, we propose a new selection of quadrature points that works in the general setting of mixed continuity non-uniform isogeometric spaces and we propose an algorithm for the computation of a corresponding set of positive weights. Finally, we show that the row-wise formation strategy allows for the direct construction of the system matrix in the sparse matrix data structure, yielding significant savings in memory operations with respect to standard assembly approaches.

REFERENCES

[1] F. Calabrò, G. Sangalli, M. Tani, Fast formation of isogeometric Galerkin matrices by weighted quadrature, *Computer Methods in Applied Mechanics and Engineering* (2017) **316**:606-622.