Function Reconstruction in (B-Spline) Material Point Method

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ABSTRACT

The Material Point Method [1] is a particle-mesh method in which particles, so-called material points, are used to carry the physical properties of a continuum. A background mesh is used to solve the equations of motion and momentum. MPM has shown to be successful in simulating problems that involve large deformations and history-dependent constitutive models.

It is common in MPM to adopt piecewise linear Lagrange basis functions to project properties from the material points to the background grid. However, the discontinuity of the gradient of the basis functions leads to non-physical oscillations, known as grid crossing errors, affecting the quality of the numerical solution. Furthermore, the direct mapping of material point data to the background grid limits the spatial accuracy of MPM.

The recently proposed conjunction of B-spline basis functions and a reconstruction technique [2] that combines Least Squares Approximation with local Taylor basis functions, known as the Taylor Least Squares (TLS) technique, significantly reduces these shortcomings. In many cases, the use of a consistent mass matrix further improves the spatial accuracy of MPM, requiring efficient solution techniques for the resulting linear systems.

In this talk we describe B-spline MPM with the TLS technique (TLS-BSMPM) and illustrate its performance on one-dimensional examples with small and large deformations.

REFERENCES

[1] D. Sulsky, Z. Chen and H.L. Schreyer, "A particle method for history-dependent materials", Computer Methods in Applied Mechanics and Engineering, Vol. 118, pp. 179 − 196, (1994)

[2] E. Wobbes, M. Möller, V. Galavi and C. Vuik. "Conservative Taylor Least Squares reconstruction for material point methods", Delf University of Technology, Technical Report, 2018