Towards effective (very) high accurate remapping method on polyhedrons using a posteriori limiting

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ABSTRACT

In this presentation, we will focus on the development of high accurate 3D conservative projection method on polyhedral meshes following the first attempts in [1]. Our technique is based on intersection polyhedra calculation between the initial mesh onto which the cell-centered data are defined and the target mesh onto which the data are remapped.

With this method, if the intersection and the integration are exact and highly accurate respectively, the main error of the projection method is due to the representation of the underlying data. To obtain a formal higher accurate method, it is sufficient to increase the accuracy of the representation of the underlying data (i.e. reconstructing N-th accurate polynomials implies a $(N+1)$-th nominal order of accuracy).

Unfortunately, in practice, some limiting must be apply to the polynomial reconstruction to avoid over-undershoots or Gibbs phenomenon. Classical limiters have been designed for piece-wise linear reconstruction, conversely the MOOD paradigm (multi-dimensional optimal order detection [2, 3]) can manage higher polynomial reconstruction ($\mathbb{P}_N$ with $N > 1$) thanks to an 'a posteriori' detection that identifies problematic cells. Those "bad" cells are successively re-updated after some local order decrementing of the polynomial reconstruction. This iterative process eventually stops when the problematic cell is updated with a $\mathbb{P}_0$ reconstruction. In this case, the local effective order of accuracy is bounded by 1 (as it must be close to any discontinuous solutions).

In this work we have implemented an exact polyhedral intersection coupled with a high accurate numerical integration. Polynomial reconstructions of maximal degree up to 5 are considered with MOOD limiting. We will emulate an ALE code by remapping density, momentum and total energy profiles showing how density, specific internal energy and pressure could be maintained in bounds. Cyclic remapping test cases on general polyhedral meshes will be considered and we will show that effective high accuracy can be reached on smooth problems.

References

[1] R. Loubère, S.Diot, M.Kucharik, "High order remapping method using MOOD paradigm", MULTIMAT'13, San Francisco, (2013).

[2] R. Loubère, M. Dumbser, and S. Diot. "A new family of high order unstructured MOOD and ADER finite volume schemes for multidimensional systems of hyperbolic conservation law", *Communication in Computational Physics*, 16:718763, 2014.

[3] S. Diot, S. Clain, and R. Loubère. "Improved detection criteria for the multi-dimensional optimal order detection (MOOD) on unstructured meshes with very high-order polynomial" *Computers and Fluids*, 64:43 63, 2012.

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