TOWARD A TRULY MESHFREE HIGH-RESOLUTION METHOD FOR COMPRESSIBLE FLOW

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In the world of computational compressible fluid dynamics on meshes, "high-resolution" usually refers to locally conservative finite difference schemes that embody the essentially one-dimensional notions of high-order differencing, nonlinear limiters, upwinding, and Riemann solvers to model transient shock waves. These methods are generally regarded as the best available for this type of simulation. The classical meshfree technique of SPH used artificial viscosity to model shock waves, but the concept does not generalize satisfactorily to variants that use more recent and accurate meshfree derivative estimates. Extrapolation of traditional high-resolution ideas to the meshfree world has been attempted before, but success has been limited. One of the principle difficulties has been the fact that with meshes, even in higher dimensions, there is a readily identifiable boundary between two cells and thus a definite concept of "left" and "right" which is used in the definition of limiters, and in the solution of the Riemann problem. In multi-dimensional meshfree methods, a natural "left" and "right" concept is elusive. In a *truly meshfree* high-resolution scheme, notions of "left" and "right" are not needed, because the totality of neighboring points are used.

Space-time local regression estimators (i.e. the moving-least squares "interpolant"), in concert with wave-weights [1], provide truly meshfree high-order upwind derivative estimates. Recently a new variety of truly meshfree limiter based on "tuned" local regression estimators was reported [2]. So three of the four essential ingredients are in place. We report on recent progress in developing a truly meshfree Riemann solver to complete the generalization of the four traditionally one-dimensional ingredients.

References

[1] G. A. Dilts, A. Haque, J. Wallin, "Tuned Local Regression Estimators for the Numerical Solution of Differential Equations," *Lecture Notes in Computer Science and Engineering*, v. 26, p. 87-104, 2002.

[2] G. A. Dilts, "Implementation and Application of Tuned Regression Estimators", Fifth World Congress on Computational Mechanics, Vienna Austria, July 7-12, 2002.