RESIDUAL DISTRIBUTION SCHEMES WITH VARIABLE DISTRIBUTION COEFFICIENTS

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We propose a new formulation of the residual distribution (*RD*) method for steady hyperbolic conservation laws. Traditionally, the residual is distributed in parts to the degrees of freedom by means of piecewise-constant distribution coefficients. To retain the upwind character of the scheme, the calculation of these distribution coefficients required a sub-division of the element for high-order approximations. The sub-division of 3D or very high-order elements [1,2] was an inefficient, complex and error-prone process.

In this new formulation, we avoid the sub-division by defining variable non-linear distribution coefficients over the whole high-order element. These coefficients are anisotropic and depend on the hyperbolic operator. The new *RD* form makes the extension to generic 2D and 3D high-order elements much simpler. Moreover, we show that it does not suffer from the undamped modes in $k=1$ quadrilaterals, as found in [3].

The RD variant proposed here is in fact a Petrov-Galerkin Finite Element method. However, this method does retain many of the characteristics of the *RD* framework: a globally continuous discrete solution defined on Lagrangian P_k elements; a residual computed by integration of the differential operator and a very compact stencil, stabilization via a generalization of the *RD* multidimensional upwinding.

References

[1] R. Abgrall, P.L.Roe, *High order fluctuation schemes on triangular meshes*, Journal of Computational Physics. 19 (2003) 3-36.

[2] M. Ricchiuto, N. Villedieu, R. Abgrall and H. Deconinck, *On uniformly high--order accurate residual distribution schemes for advection diffusion*, J. Comput. Appl. Math. 215 (2008), 547-556.

[3] D.T Rubino, *Residual distribution schemes for advection and advection--diffusion problems on quadrilateral and hybrid meshes*, PhD Thesis, Politecnico di Bari, 2005