A thermodynamically compatible splitting procedure in hyperelasticity

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A material is hyperelastic if the stress tensor is obtained by variation of the stored energy function. The corresponding 3D mathematical model of hyperelasticity written in the Eulerian coordinates represents a system of 14 conservative partial differential equations submitted to stationary differential constraints. A classical approach for numerical solving of such a 3D system is a geometrical splitting : the 3D system is splitted into three 1D systems along each spacial direction and solved then by using a Godunov type scheme. Each 1D system has 7 independent eigenfields corresponding to contact characteristics, longitudinal waves and shear waves. Eulerian Riemann solvers which can be found in the literature show up an important diffusion of shear waves. In a special case where the specific energy is a sum of two parts : the hydrodynamic part depending only on the density and the entropy, and the shear part which is unaffected by the volume change, we propose an additional splitting which allows us to reduce each 1D sub-system to three new sub-systems containing only three waves. Such a splitting has multiple advantages. First, each subsystem is hyperbolic, if the the full system is hyperbolic. Second, the corresponding eigenvalues can be found explicitly. Third, the numerical diffusion of shear waves is reduced. Numerical tests are proposed to confirm the advantage of the new approach.

Références

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