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Time integration of thermoelastic systems based on an energy/entropy formulation

I. Romero

E.T.S.I. Industriales, Universidad Politécnica de Madrid
José Gutiérrez Abascal, 2; 28006 Madrid (Spain)
ignacio.romero@upm.es http://bigmac.mecaest.etsii.upm.es

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ABSTRACT

The dynamics of (non-equilibrium) thermodynamic systems can be generated from the total energy and entropy using a recently proposed framework known as GENERIC, which can be viewed as an extension of Hamiltonian mechanics (see [1] for a comprehensive review). In this formalism, the energy is responsible for the evolution of the reversible dynamics, and the entropy acts as a generator of the irreversible contributions. Both components are orthogonal in a certain sense, hinting at a rich geometric structure which has not been exploited in the context of numerical methods yet.

The GENERIC formulation has been extensively employed in fluid mechanics, rheology, molecular dynamics, relativistic thermodynamics, and just recently it has been applied to some problems in solid mechanics [2]. In this work we will look at the application of the GENERIC framework to irreversible examples in solid mechanics, and more specifically to nonliner thermoelasticity. We will show the design and analysis of time integration algorithms for this problem that take advantage of the particular structure of the GENERIC equations of evolution.

References

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[2] M. Hütter and T. A. Tervoort. Finite anisotropic elasticity and material frame indifference from a nonequilibrium thermodynamics perspective. *Accepted in J. Non-Newtonian Fluid Mechanics*, 2007.