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COMPUTATIONAL FINITE STRAIN VISCOELASTICITY FOR LOADING CONDITIONS ON MULTIPLE TIME SCALES BY ADAPTIVE STEP SIZE CONTROL

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Solids and structures frequently undergo loading characteristics living on multiple time scales; therein e.g. continuous, long-term loading intervals of moderate intensity are interrupted by high-intensity, short-term loading events. For the numerical analysis of this class of loading histories, numerical methods must be toughened up to effectively tackle the multiple time scale issue.

The objective of this work is to propose an algorithmic solution within a nonlinear finite element framework that enables the analysis of viscoelastic solids subject to suchlike loading conditions. The concept is based on four pillars (i) Time integration of viscoelastic evolution equations at finite strains is carried out by a 4th order Runge-Kutta method which obtains full nominal order most effectively by fulfilling a recently established *consistency condition* [1]. In parallel (ii) the linear Backward-Euler is employed for time integration, (iii) such that the integrators of different order and accuracy provide an on-the-fly estimate of the error in time integration. (iv) Adaptive step-size control is directed by the estimated error and a prescribed error tolerance.

In representative numerical examples we illustrate the performance of the present method and underpin the computational savings by speed-up factors compared to constant time step sizes. Beyond isotropic viscoelasticity the examples cover anisotropic materials following the approach in [2]. The present approach combines most effectively accuracy and efficiency with an expected impact on the broad class of viscoelastic materials.

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