
A high-order implicit time integration method for linear and nonlinear dynamics with efficient computation of accelerations

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Abstract

An algorithm for a family of self-starting high-order implicit time integration schemes with controllable numerical dissipation is proposed for both linear and nonlinear transient problems. This work builds on the previous works of the authors on elastodynamics by presenting a new algorithm that eliminates the need for factorization of the mass matrix providing benefit for the solution of nonlinear problems. The improved algorithm directly obtains the acceleration at the same order of accuracy of the displacement and velocity using vector operations (without additional equation solutions). The nonlinearity is handled by numerical integration within a time step to achieve the desired order of accuracy. The new algorithm fully retains the desirable features of the previous works:

1. The order of accuracy is not affected by the presence of external forces and physical damping;
2. The amount of numerical dissipation in the algorithm is controlled by a user-specified parameter

ρ_{∞} , leading to schemes ranging from perfectly nondissipative A -stable to L -stable; 3. The effective stiffness matrix is scale problems. The proposed algorithm, with its elegance and computational advantages, is shown to replicate the numerical order time integration methods commonly used in commercial software produces significantly polluted acceleration response order time integration schemes presented here perform noticeably better at suppressing spurious high-frequency oscillation.

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