Conservative fourth-order time integration of non-linear dynamic systems - DTU Orbit
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Conservative fourth-order time integration of non-linear dynamic systems
An energy conserving time integration algorithm with fourth-order accuracy is developed for dynamic systems with nonlinear stiffness. The discrete formulation is derived by integrating the differential state-space equations of motion over the integration time increment, and then evaluating the resulting time integrals of the inertia and stiffness terms via integration by parts. This process introduces the time derivatives of the state space variables, and these are then substituted from the original state-space differential equations. The resulting discrete form of the state-space equations is a direct fourth-order accurate representation of the original differential equations. This fourth-order form is energy conserving for systems with force potential in the form of a quartic polynomial in the displacement components. Energy conservation for a force potential of general form is obtained by addition of a higher order secant-type correction term. The formulation leads to a consistent representation of the motion within a time increment corresponding to cubic Hermite interpolation in time. This in turn leads to excellent phase representation with only a small fourth-order error, permitting integration of oscillatory systems with only a few integration points per period. Three numerical examples demonstrate the high accuracy of the algorithm. (C) 2015 Elsevier B.V. All rights reserved.

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