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Reciprocal Mass Matrices and Feasible Time Step Estimates for Explicit Dynamics

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Recently, reciprocal mass matrices, i.e. directly constructed inverse mass matrices, were proposed by several authors [e.g. 1-2] as an efficient alternative to diagonally lumped or selectively scaled mass matrices in explicit dynamics. These sparse reciprocal mass matrices allow trivial computation of the nodal accelerations from the total force vector. A free parameter in the formulation allows for selective inertia scaling, i.e. the critical time step is increased without deteriorating the low frequency response. To exploit the full potential of reciprocal mass matrices, accurate, efficient and conservative time-step estimates are required.

This contribution focusses first on the question why existing element-based time step estimates are in general not conservative for reciprocal mass matrices. Then, a novel local, node-based time step estimate for reciprocal mass matrices [3] is proposed. The estimate is an advancement of the nodal time step estimate for diagonally lumped mass matrices, based on Gershgorin's theorem [4], to reciprocal mass matrices. Finally, simplifications of the proposed time step estimate that improve computational efficiency, especially for contact problems with the penalty method, are discussed and evaluated by numerical examples.

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