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ON ENERGY DECAY OF TIME DISCONTINUOUS GALERKIN METHODS FOR NON-LINEAR ELASTODYNAMICS

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ABSTRACT

In the last years much research has been devoted to developing accurate and robust time integration methods for non-linear structural dynamics. To this end, filtering out the unwanted high-frequency response has been recognized as a desirable feature and various attempts have been made to introduce such a dissipative feature (see [1, 2] and the references therein, amongst others). An attractive approach is offered by the time discontinuous Galerkin (TDG) method, which has been successfully applied to linear and non-linear structural dynamics, owing to its good stability and accuracy properties (see for example [3]). Although the TDG method properly combines higher order accuracy and high-frequency dissipation, there are two main issues that deserve attention for its practical applicability. One concerns the computational cost, which in standard implementations turn out to be very high, and the other the stability of the method. The first issue has been addressed in various works and, for example, an effective implementation which successfully overcomes the high computational cost problem has been recently proposed in [4]. More open questions remain concerning the second issue, that is the unconditional stability of the method or, in other words, its unconditional energy decay, which plays a central role in non-linear elastodynamics and constitutes the main focus of the present paper. On this regard, it is proven that the TDG method in its classical formulation is unconditionally stable in linear elastodynamics but looses this desirable property when passing to non-linear problems, even if it tends to be energy-dissipative. With this in mind, a correction of the classical formulation that allows to achieve unconditional stability also in non-linear elastodynamics, i.e. renders the method truly energy-decaying, is proposed. Some numerical experiments are presented to illustrate the arguments discussed in the paper.

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