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AN IMPROVED DIFFERENTIAL QUADRATURE TIME ELEMENT METHOD

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The discretization of the spatial domain of the structural dynamic problems governed by partial differential equations results in a system of ordinary differential equations (ODEs) with time as the independent variable. The commonly known drawbacks of direct integration method (DIM) such as the classical Runge-Kutta (RK) methods of different stage and order, the Wilson θ method, the Newmark method and so on, are the numerical dissipation and dispersion, although the symplectic integration methods [1] have the energy-conserving property.

Alternatively, the ODEs can be discretized using time finite element methods (TFEM). One can construct TFEM based on the variational principles and the weighted residual methods. In a different way, the ODEs can also be solved using the differential quadrature (DQ) method [2] wherein the ODEs are discretized by DQ rule. An accurate and efficient differential quadrature time element method (DQTEM) was proposed by present authors [3] for solving ordinary differential equations (ODEs), whose numerical dissipation and dispersion is much smaller than that of ordinary DIM of single/multi steps. Two methods of imposing initial conditions were also given, which avoids the tediousness when imposing derivative initial conditions. But the dimension of the problem in DQTEM is much larger that in other common direct integration methods.

In this context, an improved DQTEM is proposed, in which the spatial and time coordinates are discretized using DQ rule concurrently; this approach reduces the dimension of the problem greatly and there is no sacrifice of accuracy at all. The fundamental equations are derived first and then the usage method is given, numerical comparisons validate the efficiency and accuracy of the proposed method.

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