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FAST TIME IMPLICIT DISCRETIZATION FOR COMPRESSIBLE FLOW EQUATIONS VIA A DISCONTINUOUS GALERKIN METHOD

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Abstract. In this study, we investigate efficient time integration techniques for a high-order accurate discontinuous Galerkin method. The method is associated to a Jacobian-free Newton-Krylov algorithm. This method is known to resolve the problem of strong restriction on the time step due to the so-called Courant-Friedrichs-Levy condition for stability of the discontinuous Galerkin scheme associated to an explicit time discretization. However, the shortcoming of implicit time integration methods is the extremely high computational cost and memory requirement induced by the large number of degrees of freedom in practical applications. In the present work, we focus on efficient preconditioning techniques. In a first time, we will review and compare techniques in the context of Jacobian-free Newton-Krylov algorithm such as block-Jacobi, LU SGS and ILU(0) preconditioners. Then, we will exploit the possibility of using approximate Jacobians as preconditioning matrix to reduce the strong computational cost and memory requirement associated to a high-order discontinuous Galerkin method. Steady-state and time-dependent solutions of the compressible Euler equations in two and three space dimensions will be considered to assess the performances of the present method.