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ACCELERATION OF IMPLICIT SCHEMES FOR LARGE SYSTEMS OF NONLINEAR ODEs*

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Abstract. Implicit integration schemes for large systems of nonlinear ODEs require, at each integration step, the solution of a large nonlinear system. Typically, the nonlinear systems are solved by an inexact Newton method that leads to a set of linear systems involving the Jacobian matrix of the ODE which are solved by Krylov subspace methods. The convergence of the whole process relies on the quality of initial solutions for both the inexact Newton iteration and the linear systems. To improve global convergence, line search and trust region algorithms are used to find effective initial solutions. The purpose of this paper is to construct subspaces of small dimension where descent directions for line search and trust region algorithms and initial solutions for each linear system are found. Only one subspace is required for each integration step. This approach can be seen as an improved predictor, leading to a significant saving in the total number of integration steps. Estimates are provided that relate the quality of the computed initial solutions to the step size of the discretization, the order of the implicit scheme and the dimension of the constructed subspaces. Numerical results are reported.

Key words. nonlinear equations, nonlinear ODE systems, inexact Newton, GMRES, line search, trust region

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