Ullah, Malik Zaka; **Ahmad, Fayyaz**; **Alshomrani, Ali Saleh**; **Alzahrani, A. K.**; **Alghamdi, Metib Said**; **Ahmad, Shamshad**; **Ahmad, Shahid**

Frozen Jacobian iterative method for solving systems of nonlinear equations application to nonlinear IVPs and BVPs. (English) Zbl 1379.65048

J. Nonlinear Sci. Appl. 9, No. 12, 6021-6033 (2016).

Summary: Frozen Jacobian iterative methods are of practical interest to solve the system of nonlinear equations. A frozen Jacobian multi-step iterative method is presented. We divide the multi-step iterative method into two parts namely base method and multi-step part. The convergence order of the constructed frozen Jacobian iterative method is three, and we design the base method in a way that we can maximize the convergence order in the multi-step part. In the multi-step part, we utilize a single evaluation of the function, solve four systems of lower and upper triangular systems and a second frozen Jacobian. The attained convergence order per multi-step is four. Hence, the general formula for the convergence order is $3 + 4(m - 2)$ for $m \geq 2$ and m is the number of multi-steps. In a single instance of the iterative method, we employ only single inversion of the Jacobian in the form of LU factors that makes the method computationally cheaper because the LU factors are used to solve four system of lower and upper triangular systems repeatedly. The claimed convergence order is verified by computing the computational order of convergence for a system of nonlinear equations. The efficiency and validity of the proposed iterative method are narrated by solving many nonlinear initial and boundary value problems.

MSC:

65L05	Numerical methods for initial value problems
65H10	Numerical computation of solutions to systems of equations
65L06	Multistep, Runge-Kutta and extrapolation methods for ordinary differential equations
34B15	Nonlinear boundary value problems for ordinary differential equations
34A34	Nonlinear ordinary differential equations and systems, general theory

Keywords:

frozen Jacobian iterative methods; multi-step iterative methods; systems of nonlinear equations; nonlinear initial value problems; nonlinear boundary value problems; convergence

Full Text: DOI Link