Ahmad, Fayyaz; **Bhutta, Toseef Akhter**; **Shoaib, Umar**; **Zaka Ullah, Malik**; **Alshomrani, Ali Saleh**; **Ahmad, Shamshad**; **Ahmad, Shahid**

A preconditioned iterative method for solving systems of nonlinear equations having unknown multiplicity. (English) Zbl 1461.65082

Algorithms (Basel) 10, No. 1, Paper No. 17, 9 p. (2017).

Summary: A modification to an existing iterative method for computing zeros with unknown multiplicities of nonlinear equations or a system of nonlinear equations is presented. We introduce preconditioners to nonlinear equations or a system of nonlinear equations and their corresponding Jacobians. The inclusion of preconditioners provides numerical stability and accuracy. The different selection of preconditioner offers a family of iterative methods. We modified an existing method in a way that we do not alter its inherited quadratic convergence. Numerical simulations confirm the quadratic convergence of the preconditioned iterative method. The influence of preconditioners is clearly reflected in the numerically achieved accuracy of computed solutions.

MSC:

65H10 Numerical computation of solutions to systems of equations

Keywords:

nonlinear equations; systems of nonlinear equations; singular Jacobian; roots with unknown multiplicity; nonlinear preconditioners; auxiliary function

Full Text: DOI

References:

[1] Ahmad, F.; Tohidi, E.; Carrasco, J.A.; A parameterized multi-step Newton method for solving systems of nonlinear equations; Numer. Algorithms: 2016; Volume 71 ,631. · Zbl 1350.65046

[2] Ullah, M.Z.; Serra-Capizzano, S.; Ahmad, F.; An efficient multi-step iterative method for computing the numerical solution of systems of nonlinear equations associated with ODEs; Appl. Math. Comput.: 2015; Volume 250 ,249-259. · Zbl 1328.65156

[3] Ahmad, F.; Tohidi, E.; Ullah, M.Z.; Carrasco, J.A.; Higher order multi-step Jarratt-like method for solving systems of nonlinear equations: Application to PDEs and ODEs; Comput. Math. Appl.: 2015; Volume 70 ,624-636.

[4] Alaidarous, E.S.; Ullah, M.Z.; Ahmad, F.; Al-Fhaid, A.S.; An Efficient Higher-Order Quasilinearization Method for Solving Nonlinear BVPs; J. Appl. Math.: 2013; Volume 2013 ,259371. · Zbl 1397.34046

[5] Ullah, M.Z.; Soleymani, F.; Al-Fhaid, A.S.; Numerical solution of nonlinear systems by a general class of iterative methods with application to nonlinear PDEs; Numer. Algorithms: 2014; Volume 67 ,223-242. · Zbl 1316.65053

[6] Montazeri, H.; Soleymani, F.; Shateyi, S.; Motsa, S.S.; On a New Method for Computing the Numerical Solution of Systems of Nonlinear Equations; J. Appl. Math.: 2012; Volume 2012 ,751975. · Zbl 1268.65075

[7] Cordero, A.; Hueso, J.L.; Martinez, E.; Torregrosa, J.R.; A modified Newton-Jarratt's composition; Numer. Algorithms: 2010; Volume 55 ,87-99. · Zbl 1251.65074

[8] Chun, C.; A method for obtaining iterative formulas of order three; Appl. Math. Lett.: 2007; Volume 20 ,1103-1109. · Zbl 1132.65040

[9] Chun, C.; On the construction of iterative methods with at least cubic convergence; Appl. Math. Comput.: 2007; Volume 189 ,1384-1392. · Zbl 1122.65326

[10] Chun, C.; Some variant of Chebshev-Halley method free from second derivative; Appl. Math. Comput.: 2007; Volume 191 ,1384-1392. · Zbl 1122.65326

[11] Osada, N.; Improving the order of convergence of iterative functions; J. Comput. Appl. Math.: 1998; Volume 98 ,311-315. · Zbl 0935.65052

[12] Noor, M.A.; Shah, F.A.; Variational iteration technique for solving nonlinear equations; J. Appl. Math. Comput.: 2009; Volume 31 ,247-254. · Zbl 1188.65067

[13] Noor, M.A.; Shah, F.A.; Noor, K.I.; Al-Said, E.; Variational iteration technique for finding multiple roots of nonlinear equations; Sci. Res. Essays: 2011; Volume 6 ,1344-1350.

[14] Noor, M.A.; Shah, F.A.; A family of iterative schemes for finding zeros of nonlinear equations having unknown multiplicity; Appl. Math. Inf. Sci.: 2014; Volume 8 ,2367-2373.

[15] Shah, F.A.; Noor, M.A.; Batool, M.; Derivative-free iterative methods for solving nonlinear equations; Appl. Math. Inf. Sci.: 2014; Volume 8 ,2189-2193.

[16] Ortega, J.M.; Rheinbodt, W.C.; ; Iterative Solution of Nonlinear Equations in Several Variables: London, UK 1970; .

[17] Traub, J.F.; ; Iterative Methods for the Solution of Equations: Englewood Cliffs, NJ, USA 1964; . · Zbl 0121.11204

[18] Hueso, J.L.; Martinez, E.; Torregrosa, J.R.; Modified Newton's method for systems of nonlinear equations with singular Jacobian; J. Comput. Appl. Math.: 2009; Volume 224 ,77-83. · Zbl 1159.65050

[19] Wu, X.; Note on the improvement of Newton's method for systems of nonlinear equations; Appl. Math. Comput.: 2007; Volume 189 ,1476-1479. · Zbl 1243.65058

[20] Noor, M.A.; Waseem, M.; Noor, K.I.; Al-Said, E.; Variational iteration technique for solving a system of nonlinear equations; Optim Lett.: 2013; Volume 7 ,991-1007. · Zbl 1288.90093

[21] Burden, R.L.; Faires, J.D.; ; Numerical Analysis: Boston, MA, USA 2001; .

[22] McNamee, J.M.; ; Numerical Methods for Roots of Polynomials, Part I: Amsterdam, The Netherlands 2007; . · Zbl 1143.65002

[23] Noor, M.A.; Shah, F.A.; A Family of Iterative Schemes for Finding Zeros of Nonlinear Equations having Unknown Multiplicity; Appl. Math. Inf. Sci.: 2014; Volume 8 ,2367-2373.

[24] Ahmad, F.; S-Capizzano, S.; Ullah, M.Z.; Al-Fhaid, A.S.; A Family of Iterative Methods for Solving Systems of Nonlinear Equations Having Unknown Multiplicity; Algorithms: 2016; Volume 9 .