

A general class of explicit pseudo two-step RKN methods on parallel computers

Gong N.H., Strehmel K., Weiner R.

Faculty of Mathematics, Mechanics and Informatics, Hanoi University of Sciences, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam; FB Mathematik und Informatik, Martin-Luther-Universität Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120 Halle, Germany

Abstract: The aim of this paper is to investigate a general class of explicit pseudo two-step Runge-Kutta-Nyström methods (RKN methods) of arbitrarily high order for nonstiff problems for systems of special second-order differential equations $y''(t) = f(y(t))$. Order and stability considerations show that we can obtain for any given p , a stable p^{th} -order explicit pseudo two-step RKN method requiring $p - 2$ right-hand side evaluations per step of which each evaluation can be obtained in parallel. Consequently, on a multiprocessor computer, only one sequential right-hand side evaluation per step is required. By a few widely-used test problems, we show the superiority of the methods considered in this paper over both sequential and parallel methods available in the literature. © 1999 Elsevier Science Ltd. All rights reserved.

Author Keywords: Parallelism; Runge-Kutta-Nyström methods; Stability; Two-Step Runge-Kutta-Nyström methods

Year: 1999

Source title: Computers and Mathematics with Applications

Volume: 38

Issue: 6-May

Page : 17-30

Link: [Scopus Link](#)

Correspondence Address: Gong, N.H.; Faculty of Mathematics, Mechanics and Informatics, Hanoi University of Sciences, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam

ISSN: 8981221

CODEN: CMAPD

Language of Original Document: English

Abbreviated Source Title: Computers and Mathematics with Applications

Document Type: Article

Source: Scopus

Authors with affiliations:

- Gong, N.H., Faculty of Mathematics, Mechanics and Informatics, Hanoi University of Sciences, 334 Nguyen Trai, Thanh Xuan, Hanoi, Viet Nam
- Strehmel, K., FB Mathematik und Informatik, Martin-Luther-Universität Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120 Halle, Germany
- Weiner, R., FB Mathematik und Informatik, Martin-Luther-Universität Halle-Wittenberg, Theodor-Lieser-Str. 5, D-06120 Halle, Germany

References:

- Fehlberg, E., Klassische Runge-Kutta-Nyström-Formeln mit Schrittweitenkontrolle für Differentialgleichungen $x'' = f(t, x)$ (1972) *Computing*, 10, pp. 305-315
- Fehlberg, E., Eine Runge-Kutta-Nyström-Formel 9-ter Ordnung mit Schrittweitenkontrolle für Differentialgleichungen $x'' = f(t, x)$ (1981) *Z. Angew. Math. Mech.*, 61, pp. 477-485
- Fehlberg, E., Filippi, S., Gräf, J., Ein Runge-Kutta-Nyström-Formelpaar der Ordnung 10(11) für Differentialgleichungen $y'' = f(t, y)$ (1986) *Z. Angew. Math. Mech.*, 66, pp. 265-270
- Hairer, E., Methodes de Nyström pour l'équations différentielle $y''(t) = f(t, y)$ (1977) *Numer. Math.*, 27, pp. 283-300
- Hairer, E., A one-step method of order 10 for $y''(t) = f(t, y)$ (1982) *IMA J. Numer. Anal.*, 2, pp. 83-94
- Cong, N.H., An improvement for parallel-iterated Runge-Kutta-Nyström methods (1993) *Acta Math. Viet.*, 18, pp. 295-308
- Cong, N.H., Note on the performance of direct and indirect Runge-Kutta-Nyström methods (1993) *J. Comput. Appl. Math.*, 45, pp. 347-355
- Cong, N.H., Explicit symmetric Runge-Kutta-Nyström methods for parallel computers (1996) *Computers Math. Applic.*, 31 (2), pp. 111-122
- Cong, N.H., Explicit parallel two-step Runge-Kutta-Nyström methods (1996) *Computers Math. Applic.*, 32 (3), pp. 119-130
- Cong, N.H., RKN-type parallel block PC methods with Lagrange-type predictors (1998) *Computers Math. Applic.*, 35 (9), pp. 45-57
- Sommeijer, B.P., Explicit, high-order Runge-Kutta-Nyström methods for parallel computers (1993) *Appl. Numer. Math.*, 13, pp. 221-240
- Cong, N.H., Mitsui, T., Collocation-based two-step Runge-Kutta methods (1996) *Japan J. Indust. Appl. Math.*, 13, pp. 171-183
- Cong, N.H., Mitsui, T., A class of explicit parallel two-step Runge-Kutta methods (1997) *Japan J. Indust. Appl. Math.*, 14, pp. 303-313
- Cong, N.H., Direct collocation-based two-step Runge-Kutta-Nyström methods (1995) *SEA Bull. Math.*, 19, pp. 49-58
- Cong, N.H., Explicit pseudo two-step Runge-Kutta methods for parallel computers *Intern. J. Computer Math.*, 75, , to appear
- Cong, N.H., Strehmel, K., Weiner, R., Runge-Kutta-Nyström-type parallel block predictor-corrector methods (1999) *Advances in Computational Mathematics*, 10, pp. 115-133
- Van Der Houwen, P.J., Sommeijer, B.P., Cong, N.H., Stability of collocation-based Runge-Kutta-Nyström methods (1991) *BIT*, 31, pp. 469-481
- Hairer, E., Nørsett, S.P., Wanner, G., (1993) *Solving Ordinary Differential Equations, I. Nonstiff Problems*, , Second Revised Edition, Springer-Verlag, Berlin
- Cong, N.H., Explicit Pseudo Two-step RKN Methods with Stepsize Control, , submitted
- Hairer, E., Unconditionally stable methods for second order differential equations (1979) *Numer. Math.*, 32, pp. 373-379
- Abramowitz, M., Stegun, I.A., (1970) *Handbook of Mathematical Functions*, , National Bureau of Standards Applied Mathematics Series 55, Dover, New York
- Burrage, K., (1995) *Parallel and Sequential Methods for Ordinary Differential Equations*, , Clarendon Press, Oxford
- Filippi, S., Gräf, J., Ein Runge-Kutta-Nyström-Formelpaar der Ordnung 11(12) für Differentialgleichungen der Form $y'' = f(t, y)$ (1985) *Computing*, 34, pp. 271-282
- Filippi, S., Gräf, J., New Runge-Kutta-Nyström formula-pairs of order 8(7), 9(8), 10(9) and 11(10) for differential equations of the form $y'' = f(t, y)$ (1986) *J. Comput. Appl. Math.*, 14, pp. 361-370
- Shampine, L.F., Gordon, M.K., (1975) *Computer Solution of Ordinary Differential Equations, the Initial Value Problems*, , W.H. Freeman and Company, San Francisco, CA

- Hull, T.E., Enright, W.H., Fellen, B.M., Sedgwick, A.E., Comparing numerical methods for ordinary differential equations (1972) SIAM J. Numer. Anal., 9, pp. 603-637
- Nyström, E.J., Über die numerische Integration von Differentialgleichungen (1925) Acta Soc. Sci. Fenn., 50 (13), pp. 1-54
- Beentjes, P.A., Gerritsen, W.J., (1976) Higher Order Runge-Kutta Methods for the Numerical Solution of Second Order Differential Equations Without First Derivative, , Report NW 34/76, Centre for Mathematics and Computer Science Amsterdam