RKN-type parallel block PC methods with Lagrange-type predictors

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Abstract: This paper describes the construction of block predictor-corrector methods based on Runge-Kutta-Nystr??m correctors. Our approach is to apply the predictor-corrector method not only at step points, but also at off-step points (block points), so that in each step, a whole block of approximations to the exact solution at off-step points is computed. In the next step, these approximations are used to obtain a high-order predictor formula using Lagrange interpolation. By suitable choice of the abscissas of the off-step points, a much more accurately predicted value is obtained than by predictor formulas based on last step values. Since the block of approximations at the off-step points can be computed in parallel, the sequential costs of these block predictor-corrector methods are comparable with those of a conventional predictor-corrector method. Furthermore, by using Runge-Kutta-Nystr??m corrector methods, the computation of the approximation at each off-step point is also highly parallel. Application of the resulting block predictor-corrector methods to a few widely-used test problems reveals that the sequential costs are reduced by a factor ranging from 4 to 50 when compared with the best sequential methods from the literature.

Author Keywords: Parallelism; Predictor-corrector methods; Runge-Kutta-Nystr??m methods; Stability

Index Keywords: Approximation theory; Convergence of numerical methods; Initial value problems; Interpolation; Lagrange multipliers; Runge Kutta methods; Predictor corrector methods; Runge-Kutta-Nystrom method; Mathematical techniques

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