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A Hybrid Block Multistep Method for Direct Numerical Integration of Fourth Order Initial Value Problems

Authors : Adamu S. Salawu, Ibrahim O. Isah

Abstract : Direct solution to several forms of fourth-order ordinary differential equations is not easily obtained without first reducing them to a system of first-order equations. Thus, numerical methods are being developed with the underlying techniques in the literature, which seeks to approximate some classes of fourth-order initial value problems with admissible error bounds. Multistep methods present a great advantage of the ease of implementation but with a setback of several functions evaluation for every stage of implementation. However, hybrid methods conventionally show a slightly higher order of truncation for any k-step linear multistep method, with the possibility of obtaining solutions at off mesh points within the interval of solution. In the light of the foregoing, we propose the continuous form of a hybrid multistep method with Chebyshev polynomial as a basis function for the numerical integration of fourth-order initial value problems of ordinary differential equations. The basis function is interpolated and collocated at some points on the interval [0, 2] to yield a system of equations, which is solved to obtain the unknowns of the approximating polynomial. The continuous form obtained, its first and second derivatives are evaluated at carefully chosen points to obtain the proposed block method needed to directly approximate fourth-order initial value problems. The method is analyzed for convergence. Implementation of the method is done by conducting numerical experiments on some test problems. The outcome of the implementation of the method suggests that the method performs well on problems with oscillatory or trigonometric terms since the approximations at several points on the solution domain did not deviate too far from the theoretical solutions. The method also shows better performance compared with an existing hybrid method when implemented on a larger interval of solution.

Keywords : Chebyshev polynomial, collocation, hybrid multistep method, initial value problems, interpolation
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