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Behaviour of extrapolated implicit order-2 Runge-Kutta methods with and without compensated summation

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Abstract

Extrapolation involves taking a certain linear combination of the numerical solutions of a base method applied with different stepsizes to obtain greater accuracy. This linear combination is done so as to eliminate the leading error term. The technique of extrapolation in accelerating convergence has been successfully in numerical solution of ordinary differential equations. In this study, symmetric Runge-Kutta methods for solving linear and nonlinear stiff problem are considered. Symmetric methods admit asymptotic error expansion in even powers of the stepsize and are therefore of special interest because successive extrapolations can increase the order by two at time. Although extrapolation can give greater accuracy, due to the stepsize chosen, the numerical approximations are often destroy due to the accumulated round off errors. Therefore, it is important to control the rounding errors especially when applying extrapolation. One way to minimize round off errors is by applying compensated summation. In this paper, the numerical results are given for the symmetric Runge-Kutta methods Implicit Midpoint and Implicit Trapezoidal Rule applied with and without compensated summation. The result shows that symmetric methods with higher level extrapolation using compensated summation gives much smaller errors. On the other hand, symmetric methods without compensated summation when applied with extrapolation, the errors are affected badly by rounding errors.

Key Topics

Numerical solutions
Numerical approximations
Ordinary differential equations

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