Improved Runge-Kutta methods for solving ordinary differential equations

ABSTRACT

In this article we proposed three explicit Improved Runge-Kutta (IRK) methods for solving first-order ordinary differential equations. These methods are two-step in nature and require lower number of stages compared to the classical RungeKutta method. Therefore the new scheme is computationally more efficient at achieving the same order of local accuracy. The order conditions of the new methods are obtained up to order five using Taylor series expansion and the third and fourth order methods with different stages are derived based on the order conditions. The free parameters are obtained through minimization of the error norm. Convergence of the method is proven and the stability regions are presented. To illustrate the efficiency of the method a number of problems are solved and numerical results showed that the method is more efficient compared with the existing Runge-Kutta method.

Keyword: Convergence and stability region; Runge-Kutta methods; Ordinary differential equations; Two-step methods