Embedded Nested Implicit Runge-Kutta Pairs of Gauss and Lobatto Types with Global Error Control for Stiff Ordinary Differential Equations

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The problem of efficient global error estimation and control is studied in embedded nested implicit Runge-Kutta pairs [1] of Gauss and Lobatto types applied to stiff ordinary differential equations (ODEs). Stiff problems may arise in many areas of application and their accurate numerical solution is an important issue of applied mathematics. The cheap global error estimation designed recently in the mentioned Runge-Kutta pairs can severely overestimate the global error when applied to stiff ODEs [2] and, hence, it reduces the efficiency of those solvers. Therefore we explain here the reason of that error overestimation and show how to improve the mentioned computation techniques for stiff problems. Such modifications not only boost the efficiency of numerical integration of stiff ODEs, but also make the embedded nested implicit Runge-Kutta pairs with the modified global error control far superior the stiff built-in Matlab ODE solvers with only local error control.

References

[1] G. YU. KULIKOV AND S. K. SHINDIN, *Adaptive nested implicit Runge-Kutta formulas of Gauss type*, Appl. Numer. Math., 59 (2009), pp. 707–722.

[2] G. YU. KULIKOV, *Cheap global error estimation in some Runge-Kutta pairs*, IMA J. Numer. Anal., 33 (2013), pp. 136–163.