The Finite Mode Predictor-Corrector Methods in the Framework of General Linear Methods

Afsaneh Moradi, Javad Farzi*
Department of Mathematics, Sahand University of Technology

Received: 31 July 2017 Accepted: 28 Nov. 2018

Extended Abstract

Paper pages (277-294)

Introduction

General linear methods(GLM) was developed by Butcher in 1966 as an extension of the traditional Runge-Kutta and linear multistep methods [1]. The classification of GLMs is an important open and active research area. Many authors studied GLMs and developed different GLM classes for solving stiff and non-stiff problems. For example, the Diagonally-implicit multi-stage integration methods known as DIMSIM has four subclasses which is appropriate to stiff and non-stiff problems with capability of implementing in parallel or sequential forms [2]. In this paper we study the GLM representation of the predictor-corrector (PC) schemes in finite mode. The PC schemes are a class of practical schemes for solving initial value problems. The basic scheme (corrector) is an implicit scheme in which the implementation is accomplished by an iteration process with a rather good initial approximation evaluated by predictor method. The built in error estimation with local extrapolation is one of major advantages of PC schemes based on Adams schemes. In new formulation based on GLM we have enforced Milne estimation in the internal or external iterations. We present a closed form stability function for derived schemes. Numerical implementation and comparisons illustrate that in new formulation based on GLM framework we obtain more accurate solutions. This new formulation provide the opportunity of more

Material and methods

The methodology of this paper is based on the constructing matrix-vector formulation of the PC schemes. The matrix dimensions depend on the step numbers and the number of iterations of the PC finite mode. The derived GLM method is a scheme with r internal and s external stages. These stages are specified by the step numbers and a finite number of iterations.

Results and discussion

The general linear methods are a large class of schemes that include the traditional schemes such as Runge-Kutta methods. Among the PC schemes based on Adams linear multistep methods we can easily choice the methods with different step numbers and different orders. It is easy to estimate the local truncation errors. The stability function is available in the closed form. The local extrapolation method provides the application of Milne estimation in the internal and external stages of the PC iterations. In fact, we can control the error and improve the accuracy and locally increase the order of the method.

Conclusion

We have studied a reformulation of a class of predictor-corrector schemes in the new framework of general linear methods. The new schemes have the following properties:

- The Adams linear multistep methods are a large class of schemes including implicit and explicit schemes. We can choose Adams choice methods with different step numbers and orders.
- There is cheap error estimation for PC schemes known as Milne estimation and it is possible to use this error estimation in internal and external stages.
- The stability function of the resulting GLM is available for further developments and study of the stability properties.
- The new GLM formulation provides accurate results comparing with the original formulation in PC form.

Keywords: General linear methods, Predictor-Corrector methods, Local extrapolation, Milne estimate.

*Corresponding author: farzi@sut.ac.ir