Accepted Manuscript

Convergence analysis of the multistep Legendre pseudo-spectral method for Volterra integral equations with vanishing delays

Zhang Xiao-yong

PII: S0377-0427(17)30105-X
DOI: http://dx.doi.org/10.1016/j.cam.2017.02.040
Reference: CAM 11042

To appear in: *Journal of Computational and Applied Mathematics*

Received date: 30 April 2016
Revised date: 29 September 2016

Please cite this article as: X.-y. Zhang, Convergence analysis of the multistep Legendre pseudo-spectral method for Volterra integral equations with vanishing delays, *Journal of Computational and Applied Mathematics* (2017), http://dx.doi.org/10.1016/j.cam.2017.02.040

Convergence analysis of the multistep Legendre pseudo-spectral method for Volterra integral equations with vanishing delays

Zhang Xiao-yong*

Department of Mathematics, Shanghai Maritime University,
Haigang Avenue, 1550, Shanghai, 201306, China

Abstract. In this paper, we extend the single-step pseudo-spectral method for second kind Volterra integral equations with vanishing variable delays to the multistep pseudo-spectral method. We also analyze the convergence of the *hp*-version of the multistep pseudo-spectral method under the L^2-norm, and show that the scheme enjoys high order accuracy and can be implemented in a stable and efficient manner. In addition, it is very suitable for long time calculations and large step size situations. Numerical results show good agreement with the theoretical analysis.

Key words. Volterra integral equation, multistep method, convergence.

AMS subject classifications 45D05, 45G10, 41A10, 65L60, 65L70

1 Introduction

The Volterra integral equations (VIEs) with delays arise in many problems, such as the particle transport problems of astrophysics, potential theory and Dirichlet problems, electrostatics and radiative heat transfer problems. Some numerical methods for VIEs with delays have also been proposed. These works include the block-by-block method, the piecewise polynomial collocation method and Runge-Kutta method, etc..(see, e.g.,[4, 5, 7, 9–12, 17, 18, 22]).

However, methods mentioned above are all lower order methods. In contrast to any method of algebraic power of mesh size, the spectral collocation method often provides exceedingly accurate numerical results with relatively fewer degrees of freedom. One of the characteristics of the spectral method is that it is required that the problem is defined in a comparison regular region. Since the integral equation satisfies this requirement, and therefore global methods, such as spectral methods, are perhaps a better candidate for numerical

*zhxiyo20@sina.com