Received: 27 June 2017 | Revised: 9 October 2017 | Accepted: 5 January 2018

DOI: 10.1002/num.22245

WILEY

RESEARCH ARTICLE

Convergence rate of collocation method based on wavelet for nonlinear weakly singular partial integro-differential equation arising from viscoelasticity

Somveer Singh | **Vijay Kumar Patel** | **Vineet Kumar Singh**

Department of Mathematical Sciences, Indian Institute of Technology (Banaras Hindu University), Varanasi, India

Correspondence
Vineet Kumar Singh, Department of Mathematical Sciences, Indian Institute of Technology (Banaras Hindu University), Varanasi, India.
Email: vksingh.mat@iitbhu.ac.in

Funding information
The financial support from Science and Engineering Research Board (SERB) with sanction order no. YSS/2015/001017.

The main aim of this research article is to propose and analyze a Legendre wavelet collocation method (LWCM) for the nonlinear weakly singular partial integro-differential equation (SPIDE) arising from viscoelasticity subject to the given initial and boundary conditions. This problem can be found in the mathematical modeling of physical phenomena involving viscoelastic forces. Operational matrix of integration of Legendre wavelets along with collocation method are utilized to reduce the original SPIDE into the nonlinear system of algebraic equations. Some numerical results are presented to simplify applications of operational matrix formulation and reduce the computational cost. Convergence analysis, numerical stability and rate of convergence (C-order) of the proposed method are also investigated by considering a test function. Numerical results confirm the predicted convergence rates and also exhibit optimal accuracy in the L^2 and L^∞ norms. Finally, we compare the proposed LWCM with well-known Crank-Nicolson and Crandall's methods (for instance, see Table 4).

KEYWORDS
partial integro-differential equation, two dimensional Legendre wavelets, operational matrix of integration, collocation method, convergence analysis

1 | INTRODUCTION

Mathematical modelling of real problems usually results in functional equations such as partial differential equations [1, 2], integral equations [3], delay differential equations, integro-differential equations