Using 1D-IRBFN Method for Solving High-Order Nonlinear Differential Equations Arising in Models of Active-Dissipative Systems

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ABSTRACT

We analyse a type of nonlinear partial differential equations arising in modelling elastic waves, coupled oscillators, reaction fronts and similar dissipative systems [1-3]. The equations are nonlinear and involve 6th-order spatial derivative. To numerically solve the equations we use the one-dimensional integrated radial basis function network (1D-IRBFN) method. The method has been previously developed in [4] and successfully applied to several engineering problems such as structural analysis [4], viscous and viscoelastic flows [5] and fluid-structure interaction [6]. A more traditional and commonly used approach is to differentiate a function of interest to obtain approximate derivatives. However, this leads to a reduction in convergence rate for derivatives and this reduction is an increasing function of derivative order. Accordingly, differentiation magnifies any error. To avoid this problem and recognising that integration is a smoothing process, the proposed 1D-IRBFN method uses the integral formulation, where spectral approximants are utilised to represent highest-order derivatives under consideration and then integrated analytically to yield approximate expressions for lower-order derivatives and the function itself. Our preliminary results demonstrate good performance of the 1D-IRBFN algorithm for the equations under consideration. Examples of numerical solutions are obtained and discussed from both numerical and physical viewpoints.

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