Fractional Alternative Legendre Polynomials for Solving Fractional Partial Differential Equations with Delay

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Extended Abstract

Introduction

Many problems which appear in different science such as economics, pharmacy, signal processing, electromagnetism, electrochemistry, dynamics, quantum and statistical mechanics, solid mechanics, and fluid traffic model can be modeled by using fractional partial differential equations with delay.

Some of fractional partial differential equation cannot be solved by the well-known exact methods. Hence, it is desirable to introduce numerical methods with high accuracy to solve these equations numerically.

During the last decades, several methods have been used for solving fractional partial differential equations, such as eigenvector expansion method, homotopy-perturbation method, variational iteration method, decomposition method, finite difference approximations, Legendre collocation method, Chebyshev polynomials, Bernstein polynomials, Legendre wavelet method, Chelyshkov wavelets.

In this paper, a new numerical method based upon fractional-order alternative Legendre polynomials approximation for solving the system of fractional partial differential equations with delay is presented.

Material and methods

In this paper, the pseudo-operational matrices of the integer and fractional derivatives for the fractional-order alternative Legendre polynomials are introduced for the first time. These operational matrices and the Gauss-Legendre collocation method are used to solve a set of delay differential equations with fractional derivatives.

Results and discussion

We solve some test problems by using present technique to demonstrate the applicability and accuracy of the proposed method.

The reported results demonstrate that there is a good agreement between approximate solution and exact solution. Also, the numerical experiments reported in the tables indicate that only a small value of the fractional alternative Legendre polynomials is needed to achieve high accuracy and satisfactory results.

Conclusion

The following conclusions were drawn from this research.

- The main advantage of this method is that it reduces the main problem to a system of algebraic equations which can be easily solved by using Newton's iterative method.
- Fractional-order alternative Legendre polynomials are a powerful mathematical tool to obtain the numerical solution of various kind of problems with little additional works.
- The pseudo-operational matrices of the integer and fractional derivatives for the fractional alternative Legendre polynomials are introduced. These matrices, in comparison to the operational matrix, are more accurate.
- It is shown that satisfactory results can be obtained only using a small number of basic functions, which is illustrated by the presented examples.

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