Commentary
Volume 12:6, 2021

Journal of Physical Mathematics

ISSN: 2090-0902 Open Access

A New Computational Method for Solving Nonlinear Stochastic Ito-Volterra Integral Equation

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Description

An efficient and accurate computational method based on the hybrid Legendre Wavelets (LWs) with Modified Hat Functions (MHFs) are proposed for solving of nonlinear stochastic Itˆo-Volterra integral equations. For this reason, a new stochastic operational matrix of LWs is derived and a collocation method based on MHFs is employed for forming stochastic operational matrix. The LWs and their operational matrices of integration and stochastic Itˆo-Volterra integral are used into corresponding nonlinear system, which can be simply solved to achieve the solution of problems. Furthermore, convergence of LWs and MHFs is investigated. By Several examples, efficiency and accuracy of the proposed method are presented.

Many different methods and modelling problems lead to stochastic equations, in issues of science. Stochastic analysis has been an interesting research area in mathematics, geophysics, fluid mechanics, chemistry, biology, epidemiology, Microelectronics, theoretical physics, economics and finance. In these areas, the behaviour of dynamical systems are often dependent on a Gaussian white noise and a noise source, governed by certain probability laws, so that modelling such phenomena naturally requires the use of various stochastic differential equations, in more complicated cases, stochastic integral equations and stochastic Integro-differential equations.

Although often analytic solution of these equations is not available, numerical stochastic method becomes a particular way to face this difficulty. Today, many orthogonal functions or polynomials have be used to find a numerical solution, for integral equations, hybrid of block-pulse and parabolic functions, hat functions, Bernstein polynomials, Chebyshev polynomials, the numerical solutions of stochastic Volterra-Fredholm integral equations have been obtained by hybrid Legendre Block-Pulse Functions (BPFs) and stochastic operational matrix, Haar wavelet.

In recent years, wavelets theory is one of the growing and predominantly new methods in the area of mathematical and engineering research. It has been applied in vast range of engineering sciences; particularly, they are used very successfully for waveform representation and segmentations in signal analysis and time-frequency analysis and in the mathematical sciences it is used in thriving manner for solving variety of linear and nonlinear differential and partial differential equations and integral equations for easy implementation. The following stochastic Itˆo-Volterra integral equation with LWs and MHFs basis, on the interval 0,1 is used to find an approximate solution.

Wiener process

The Wiener process is the most important stochastic processes in the theory and applications. It is a natural model of Brownian motion that describes a random, but continuous motion of a particle, subjected to the influence of a large number of chaotically moving molecules of the liquid. Any displacement of the particle over an interval of time as a sum of many almost independent small influences is normally distributed with expectation zero and variance proportional to the length of the time interval. Displacements over disjoint time intervals are independent.

LWs wavelet

Wavelets constitute a family of functions constructed from dilation and translation of a single function ψ called the mother wavelet. When the dilation parameter a and the translation parameter b varies continuously, we have the following family of continuous wavelets.

Conclusion

For solving nonlinear stochastic, the stochastic operational matrix of Itˆo-Volterra integration of the LWs was derived and applied, Itˆo-Volterra integral equations, in this study. In the proposed method, a new technique for commuting nonlinear terms in problems under study was presented. Also, in order to solve problems under consideration, some useful properties of the LWs were derived and used. Applicability and accuracy of the proposed method were checked on some examples. Moreover, the results of this proposed method were in a good agreement with the exact solutions. Furthermore, in the mathematics, finance, chemistry, physics and biology, as some applications, the proposed computational method

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Received: 27 September, 2021; **Accepted:** 11 October, 2021; **Published:** 18 October, 2021

was applied to obtain approximate solutions for some stochastic problems.

Conflict of Interest

Author has nothing to disclose.

How to cite this article: Sharaf, Fatemeh and Behrooz Basirat. "A New Computational Method for Solving Nonlinear Stochastic Ito-Volterra Integral Equation ." *J Phys Math* 12 (2021) : 340.