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Editorial note on the special issue: "Fractional calculus models for the dynamics of complex systems"

The fractional derivatives and integrals and their potential uses have earned a great importance, mainly because they have become powerful instruments with more accurate, efficient and successful results in mathematical modelling of several complex phenomena in numerous seemingly diverse and widespread fields of science, engineering and finance. As the fractional dynamical systems grow, mature and develop, it is very important to focus on the most promising novel directions that were worked out based on the novel methods and schemes handed over recently in the field. The key objective of this special issue was to focus on recent advancements and future challenges on the basic foundation and applications of the fractional derivatives and integrals in sciences, finance and engineering.

Below we are giving a short details of each accepted paper of our special issue.

In the manuscript "***Analysis of fractional model of guava for biological pest control with memory effect***", *a guava fruit model associated with a non-local and non-singular fractional derivative for the interaction into guava pests and natural enemies is studied. The positivity analysis and equilibrium analysis for the fractional guava fruit model is discussed. The numerical results are demonstrated to prove our theoretical results. The graphical behavior of solution of the fractional guava problem at the distinct fractional order values and at various parameters shows new vista and interesting phenomena of the model. The results are indicating that the fractional approach with non-singular kernel plays an important role in the study of different scientific problems. The suggested numerical scheme is very efficient for solving nonlinear fractional models of physical importance.*

*In this work "**Optimal bang-bang control for variable-order dengue virus; numerical studies"**, optimal control of a novel variable-order nonlinear model of dengue virus is studied. Bang-bang control is suggested to minimize the viral infection as well as quick clearance of the virus from the host. Necessary conditions for the control problem are given. The variable-order derivatives are given in the sense of Caputo. Moreover, the parameters of the proposed model are dependent on the same variable-order fractional power. Two numerical schemes are constructed for solving the optimality systems. Comparative studies and numerical simulations are implemented. The variable-order fractional derivative can be describe the effects of long variable memory of time dependent systems than the integer order and fractional order derivatives.*

*In this paper "**A hybrid fractional optimal control for a novel Coronavirus (2019-nCov) mathematical model,**" the optimal control of Coronavirus model with new fractional operator is presented. This operator can be written as a linear combination of a Riemann–Liouville integral* with a Caputo derivative. *Three control variables are presented in this model to minimize the number of infected populations. Necessary control conditions are derived. The weighted average nonstandard finite difference method with the new operator derivative has the best results than Grünwald-Letnikov nonstandard finite difference method with the same operator. Moreover, the proposed methods with the new operator have the best results than the proposed methods with Caputo operator.*

*In this paper "**Optimal charging of fractional-order circuits with Cuckoo search,**"* a *meta*-heuristic optimization technique called *Cuckoo search optimizer to attain the maximum charging efficiency of three common fractional-order RC circuits is used. An analytical expression of the fractional capacitor voltage is suggested such that it satisfies the boundary conditions of the optimal charging problem. The problem is formulated as a fractional-order calculus of variations problem with compositional functional. The numerical solutions are obtained with the meta-heuristic optimization algorithm's help to avoid the complexities of the analytical approach. The optimized charging function can approximate the optimal charging curve using at most 4 terms. The charging time and the resistive parameters have the most dominant effect on charging efficiency at constant fractional-order.*

*In the manuscript "**Dynamics of fractional order nonlinear system: A realistic perception with neutrosophic fuzzy number and Allee effec**t," Fractional order derivative and neutrosophic fuzzy theory are applied on the parameters of the Cobb-Douglas equation. Distinctively, cogitating fractional order derivative to study the change at each fractional stage; single-valued triangular neutrosophic fuzzy numbers to cope the uncertain situations; logistic growth function with Allee effect to analyze the factors in natural way, are the significant and novel features of this endeavor. The incorporation of the aforementioned theories and effects in the Cobb-Douglas equation, resulted in producing maximum sustainable capital investment and maximum capacity of labor force. The solutions in intervals located different possible solutions for different membership degrees, which accumulated the uncertain circumstances of a country. Explicitly, these notions add new facts and figures not only in the dynamical study of capital and labor, which has been overlooked in classical models, but also left the door open for discussion and implementation on classical models of different fields.*

*In the manuscript "**The numerical solution of high dimensional variable-order time fractional diffusion equation via the singular***

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boundary method", *the variable- order time fractional diffusion equation (VO-TFDE) is developed along with sense of the Caputo derivative. An efficient and accurate mesh free method based on the singular boundary method (SBM) and dual reciprocity method (DRM) in concomitant with finite difference scheme is proposed on three-dimensional arbitrary geometry. To discrete of the temporal term, the finite diffract method (FDM) is utilized. In the spatial variation domain; the proposal method is constructed two part. To evaluating first part, fundamental solution of (VO-TFDE) is transformed into inhomogeneous Helmholtz-type to implement the SBM approximation and other part the DRM is utilized to compute the particular solution. The stability and convergent of the proposed method is numerically investigated on high dimensional domain. To verified the reliability and the accuracy of the present approach on complex geometry several examples are investigated.*

*Inside of the manuscript entitled "**Fractional and fractal processes applied to cryptocurrencies price series"**, several tools are adopted as an instrument that can help market agents and investors to more clearly assess the cryptocurrencies price dynamics and, thus, guide investment decisions more assertively while mitigating risks. Three methods are considered. These methods namely the Auto-Regressive Integrated Moving Average (ARIMA), Auto-Regressive Fractionally Integrated Moving Average (ARFIMA) and Detrended Fluctuation Analysis, and three indices given by the Hurst and Lyapunov exponents or the Fractal Dimension. This information allows assessing the behavior of the time series, such as their persistence, randomness, predictability and chaoticity. The results suggest that, except for the Bitcoin, the other cryptocurrencies exhibit the characteristic of mean reverting, showing a lower predictability when compared to the Bitcoin. The results for the Bitcoin also indicate a persistent behavior that is related to the long memory effect. The ARFIMA reveals better predictive performance than the ARIMA for all cryptocurrencies. Indeed, the obtained residual values for the ARFIMA are smaller for the auto and partial auto correlations functions, as well as for confidence intervals.*

*In the manuscript "**A local stabilized approach for approximating the modified time-fractional diffusion problem arising in heat and mass transfer**", an efficient meshless technique for approximating the modified time-fractional diffusion problem formulated in the Riemann–Liouville sense is developed. the temporal discretization is performed by integrating both sides of the modified time fractional diffusion model. The unconditional stability of the time discretization scheme and the optimal convergence rate are obtained. Then, the spatial derivatives are discretized through a local hybridization of the cubic and Gaussian radial basis function. This hybrid kernel improves the condition of the system matrix. Therefore, the solution of the linear system can be obtained using direct solvers that reduce significantly computational cost. The main idea of the method is to consider the distribution of data points over the local support domain where the number of points is almost constant. Three examples show that the numerical procedure has good accuracy and applicable over complex domains with various node distributions. Numerical results on regular and irregular domains illustrate the accuracy, efficiency and validity of the technique.*

*In the following work "**Reliability analysis for the fractional-order circuit system subject to the uncertain fractional-order random model with Caputo type"**, an uncertain Liu process is used to describe the internal degradation of soft faults and as to chastic process is used to describe the external random shocks of hard faults. Secondly, taking into account the correlation and competition among the fault types, an extreme shock model and a cumulative shock model are constructed, and chance theory is introduced to further explore the fault mechanisms, from which the corresponding reliability indices are derived. Finally, the predictor–corrector method is applied and numerical examples are given. This paper presents a reliability analysis of a fractional-order RC circuit system with internal failure obeying an uncertain process and external failure obeying a stochastic process, and gives the calculation of the reliability indexes for different cases and the corresponding numerical simulations. A new competing failure model for a fractional-order RC circuit system is presented and analyzed for reliability, which is proved to be of practical importance by numerical simulations*

*In the work "**A new general integral transform for solving integral equations"**, a general integral transform in the class of Laplace transform is introduced. the properties of this transform is studied. comparative study with few exiting integral transforms in the Laplace family such as Laplace, Sumudu, Elzaki and G-transforms, Pourreza, Aboodh and etc. This new integral transform to convert the main problem to a simple algebraic equation is applied. After that by solving solve this algebraic equation and applying the invers operator of this transform we may obtain the solution of the main equation. Finally, this new transform is used for solving higher order initial value problems, integral equations and fractional order integral equation. It is proved that those new transforms in the class of Laplace transform which are introduced during last few decades are a special case of this general transform. It is shown that there is no advantage between theses transforms unless for special problems. Also, we can introduce new integral transforms by using this new general integral transform.*

*In the following manuscript "**Lung cancer dynamics using fractional order impedance modeling on a mimicked lung tumor setup"**, the fractional order model parameters are determined for the mechanical properties of the healthy and tumorous lung. Two protocols have been performed for a mimicked lung tumor setup in a laboratory environment. A low frequency evaluation of respiratory impedance model and nonlinearity index were assessed using the forced oscillations technique. The viscoelastic properties of the lung tissue change, results being mirrored in the respiratory impedance assessment via FOT. The results demonstrate significant differences among the mimicked healthy and tumor measurements, (p-values < 0.05) for impedance values and also for heterogeneity index. However, there was no significant difference in lung function before and after immersing the mimicked lung in water or saline solution, denoting no structural changes. Simulation tests comparing the changes in impedance support the research hypothesis. The impedance frequency response is effective in non-invasive identification of respiratory tissue abnormalities in tumorous lung, analyzed with appropriate fractional models.*

*In the manuscript "**Fractional chaotic maps based short signature scheme under human centered IoT environments"**, It is well known that in human-centered Internet of Things (IoT), the protection of sensitive data is essential to provide a protection from forgery attacks. Digital signature is the safest option in asymmetric cryptography for ensuring theownership and validity of the contact parties. This paper uses fractional chaotic maps for secure communication in human-centered IoT to present an effective provably secure short signature technique. This is existentially unforgeable under EUF-CMA at ROM. Results demonstrate the superiority of our strategy, in comparison with competitors, to take fewer overhead based on computing and communication costs alongside resilience studies. The proposed SSS achieves less processing time and less overhead community.*

*In the work "**Tailored Pharmacokinetic model to predict drug trapping in long-term anesthesia"**, a framework enabling calibration of the models during the follow up of Covid-19 patients undergoing anesthesia during their treatment and recovery period in ICU is proposed. The proposed model can be easily updated with incoming information from clinical protocols on blood plasma drug concentration profiles. Already available pharmacokinetic and pharmacodynamic models can be then calibrated based on blood plasma concentration measurements. The proposed calibration methodology allow to minimize risk for potential over-dosing as clearance rates are updated based on direct measure ments from the patient. The proposed methodology will reduce the adverse effects related to over-dosing,* *which allow further increase of the success rate during the recovery period.*

*In the manuscript entitled "**Finite-Time Stabilization of a Perturbed Chaotic Finance Model**" the main aim is to design a controller that develops a robust, stable financial closed-loop system to address the challenges above by (i) attracting all state variables to the origin, (ii) reducing the oscillations, and (iii) increasing the gradient of the convergence. Theoretical analysis proofs and computer simulation results verify that the proposed controller compels the state trajectories, including trajectories outside the basin of attraction, to the origin within finite time without oscillations while being faster than the other controllers discussed in the comparative study section.*

Conclusions: This article proposes a novel robust, nonlinear finite-time controller for the robust stabilization of the chaotic finance model. It provides an in-depth analysis based on the Lyapunov stability theory and computer simulation results to verify the robust convergence of the state variables to the origin.

We believe that this special issue will be very useful for researchers and scientists.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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