



Editorial

Editorial for Special Issue “Continuous/Discrete-Time Fractional Systems: Modelling, Design and Estimation”

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1. Introduction

The notion of a system is very old. Proof of this is Aristotle’s statement that “the whole is greater than the sum of its parts,” which defines the basic problem of systems today. For many years, systems problems remained philosophical questions due to the lack of mathematical techniques capable of solving them. It was not until 1930 that von Bertalanffy proposed the notion of general systems theory. Among the advantages of this system were that it avoided duplication of effort in different scientific areas and promoted unity in science. Because several problems in systems still cannot be expressed in mathematical terms, the approach of general systems theory is not limited to mathematical systems. For a broader view of the history of this topic, see [1,2].

Engineering systems are often represented by mathematical operators that process signals that are descriptions of physical phenomena that are frequently time-variable [3–6]. The areas of engineering in which the concept of a system is important include communications, robotics, signal processing, a control. Undoubtedly, the concept of a system is currently of utmost importance. Some time ago, observations began showing that fractional systems, in some cases, allow for a better representation of physical phenomena. Several books have been written on fractional systems [7–10].

In order to contribute to the advancement of the study of fractional systems, it has been decided to republish, in book format, the Special Issue “Continuous/Discrete-Time Fractional Systems: Modeling, Design, and Estimation.” Initially, the underlying idea was to avoid being limited by what could be considered a constraint: the RL/C environment [11,12]. Although we cannot say that we have been successful, we are satisfied with the truly innovative applications. We received 15 proposals; after a thorough peer-review process, eight have been published, expressing the vitality of the area while showing new ways.

2. Contributions in the Reprint

In the following, we present a brief summary of each of the published works, ordered by subject. All authors are specialists in fractional systems, and their work will undoubtedly influence the subject.

1. In [13], M. Ortigueira introduces differences as the output of linear systems called differentiators, dividing them into two classes: shift-invariant and scale-invariant. In addition, several shift-invariant differentiators and accumulators are introduced: nabla, delta, bilateral, tempered, and bilinear. For both definitions of differences, he proposes their respective ARMA-type differential equations and provides examples.



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2. In [14], V. Tarasov studies the transformation of continuous-time fractional models into discrete-time fractional models. A nonlinear equation with fractional derivatives in the form of a damped rotor with power nonlocality in time is studied and solved. An analytical solution is obtained using this method. Other applications of the method are proposed.
3. In [15], G. Bengochea and M. Ortigueira introduce scale-invariant fractional systems, which are studied using an operational framework. They present special functions that generate a vector space containing the impulse and step responses. Several numerical simulations are shown.
4. In [16], D. Canedo et al. study quantum cosmology from the perspective of fractional calculus. Using the fractional Riesz derivative, they study the Wheeler–DeWitt equation. They investigate a cosmological model accompanied by the Riesz potential and make several comparisons with previous studies on the subject.
5. In [17], S. Alaviyan et al. formulate a comprehensive framework for stability and control synthesis based on Lyapunov functions for fractional-order brushless DC motors. Several simulations verify that their proposal significantly improves upon other proposed methods. They present a family of stabilizing controllers designed to explicitly handle the respective limitations. With this work, the authors emerge as pioneers in the rigorous study of saturation and speed limitations in the control design of chaotic fractional-order systems.
6. In [18], G. Ceballos et al. develop a Lyapunov stability theory for mixed fractional-order direct model adaptive control. They assume that the adaptive control parameter is fractional-order and that the control error model is integer-order. It is shown that the control error converges to zero. Several examples related to the topic are presented.
7. In [19], M. Sánchez-Rivero et al. present a novel adaptive reference control framework for models that incorporate fractional order gradients to regulate the displacement of an inverted pendulum cart system. Two models based on fractional gradients are studied; their stability is demonstrated using Lyapunov methods under conditions of sufficient excitation. Real-time simulations and experiments in a physical configuration of the pendulum cart are presented.
8. In [20], N. Badau et al. develop a new fractional order control algorithm. A key feature of the algorithm is that it is robust to variations in the time constant. The authors study three biomedical applications and present simulations that validate the effectiveness of the adjustment method.

Conflicts of Interest: The authors declare no conflicts of interest.

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