Preface

The non-integer order calculus is as old as the integer one although up to recently its application was exclusively in mathematics. Many real systems are better described with non-integer order differential equations. This characteristic has attracted the engineers' interest in the later years and now it is a tool used in almost every area of science. The book presents high-quality research papers presented at the 8th Conference on Non-integer Order Calculus and Its Applications that was organized by the Institute of Automatic Control, Silesian University of Technology, Gliwice, Poland. The book is broadly divided into four parts reflecting particular aspects of the fractional-order calculus methods: mathematical foundations, modeling and control, controllability and stability, and applications.

The first part contains papers focus on general concepts of non-integer order calculus and differential equations such as existence of solutions of fractional impulsive integro-differential equations, approximation of non-integer order integrator with the use of diffusive realization of pseudo-differential operator, approximation of non-integer order integrator with the use of diffusive realization of pseudo-differential operator, Cayley–Hamilton theorem for fractional linear systems, composition properties of output-additive switching scheme with fractional constant-order differ-integral, dynamic properties of the variable-, fractional-order oscillation (inertial) element, properties of the discrete Mittag-Leffler two parameter function, output-additive switching strategy for a new variable type and order difference, large deviation principle for stochastic fractional differential equation and mean square stability of discrete-time fractional-order systems.

The second part provides new elements to the systems modeling and control using the theory of fractional-order systems. In particular the following topics are discussed: conformable fractional wave-like equation, parallel algorithm for reconstruction the boundary condition for the heat conduction equation with derivative of fractional order, Voigt models, optimal control problem for fractional discrete-time systems with quadratic performance index, maximum and minimum principles for the generalized fractional diffusion problem, transfer function forms for implementing a new class of fractional-order phase-lead compensators of analog type, optimal control for the fractional continuous-time Cucker–Smale model,

fractional-order integrators and differentiators using Tustin-based approximations, fractional model of transient current in organic semiconductor layers, heat transfer process in grid-holes structure, tuning non-integer order controllers, fractional-order backstepping sliding-mode controller, fractional-order transfer function models with delay and digital fractional-order PID controller.

In the third part of this volume, a bunch of new results in controllability, stability, detectability, and stabilizability of non-integer systems are given. Among others controllability of nonlinear fractional delay dynamical systems with multiple delays in control, controllability criteria for fractional systems with varying delays, controllability of nonlinear stochastic fractional integro-differential systems, realizations for fractional one-dimensional systems with digraph-based algorithm, relative controllability of nonlinear fractional delay dynamical systems, computation of the initial data of finite dimension and inputs for given outputs of linear stationary fractional differential-algebraic with delay system are presented.

The fourth part presents applications of non-integer models to: path control with Al-Alaoui rule for fractional calculus discretization, bi-fractional filtering on the Arduino Uno hardware platform, describe anomalous dielectric properties of materials whose behavior obeys to the Havriliak–Negami model, determination of state matrices of fractional-order dynamic system by use of digraphs, PI controller based on an optimal loop shape approach, mode controller design for blood glucose regulation, and methyl alcohol mass transfer in silica.

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