

Fractional Processes and Fractional-Order Signal Processing: Techniques and Applications (Signals and Communication Technology)

By Hu Sheng, YangQuan Chen, TianShuang Qiu

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Fractional processes are widely found in science, technology and engineering systems. In Fractional Processes and Fractional-order Signal Processing, some complex random signals, characterized by the presence of a heavy-tailed distribution or non-negligible dependence between distant observations (local and long memory), are introduced and examined from the ‘fractional’ perspective using simulation, fractional-order modeling and filtering and realization of fractional-order systems. These fractional-order signal processing (FOSP) techniques are based on fractional calculus, the fractional Fourier transform and fractional lower-order moments. Fractional Processes and Fractional-order Signal Processing: presents fractional processes of fixed, variable and distributed order studied as the output of fractional-order differential systems; introduces FOSP techniques and the fractional signals and fractional systems point of view; details real-world-application examples of FOSP techniques to demonstrate their utility; and provides important background material on Mittag–Leffler functions, the use of numerical inverse Laplace transform algorithms and supporting MATLAB® codes together with a helpful survey of relevant webpages. Readers will be able to use the techniques presented to re-examine their signals and signal-processing methods. This text offers an extended toolbox for complex signals from diverse fields in science and engineering. It will give academic researchers and practitioners a novel insight into the complex random signals characterized by fractional properties, and some powerful tools to analyze those signals.

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Editorial Review

Review

From the reviews:

“The book presents the theory and applications of an interesting domain in the area of signal science and technology: fractional processes and fractional order signal processing. ... The volume gives answers to several important questions related to fractional systems A collection of very useful MATLAB codes is given together with a useful list of Web addresses. Finally, we think that the present volume will soon become a reference book in the area of fractional signal processing and systems.” (Dumitru Stanomir, Zentralblatt MATH, Vol. 1245, 2012)

From the Back Cover

Fractional processes are widely found in science, technology and engineering systems. In *Fractional Processes and Fractional-order Signal Processing*, some complex random signals, characterized by the presence of a heavy-tailed distribution or non-negligible dependence between distant observations (local and long memory), are introduced and examined from the ‘fractional’ perspective using simulation, fractional-order modeling and filtering and realization of fractional-order systems. These fractional-order signal processing (FOSP) techniques are based on fractional calculus, the fractional Fourier transform and fractional lower-order moments. *Fractional Processes and Fractional-order Signal Processing*: • presents fractional processes of fixed, variable and distributed order studied as the output of fractional-order differential systems; • introduces FOSP techniques and the fractional signals and fractional systems point of view; • details real-world-application examples of FOSP techniques to demonstrate their utility; and • provides important background material on Mittag–Leffler functions, the use of numerical inverse Laplace transform algorithms and supporting MATLAB® codes together with a helpful survey of relevant webpages. Readers will be able to use the techniques presented to re-examine their signals and signal-processing methods. This text offers an extended toolbox for complex signals from diverse fields in science and engineering. It will give academic researchers and practitioners a novel insight into the complex random signals characterized by fractional properties, and some powerful tools to analyze those signals.

About the Author

Doctor YangQuan Chen has authored over 200 academic papers plus numerous technical reports. He co-authored two textbooks: "System Simulation Techniques with MATLAB®/Simulink" (with Dingyu Xue . Tsinghua University Press, April 2002, ISBN 7-302-05341-3/TP3137, in Chinese) and "Solving Advanced Applied Mathematical Problems Using Matlab" (with Dingyu Xue. Tsinghua University Press. August 2004. 419 pages in Chinese, ISBN 7-302-09311-3/O.392); and six research monographs: "Plastic Belt for Projectiles" (with Y. Shi. Shaanxi Science and Technology Press, Jan. 1995, ISBN 7-5369-2277-9/TJ.1, in Chinese), "Iterative Learning Control " (with C. Wen . Lecture Notes in Control and Information Sciences, Springer-Verlag, Nov. 1999, ISBN: 978-1-85233-190-0), "Iterative Learning Control" (with Hyo-Sung Ahn and Kevin L. Moore. Springer, July 2007, ISBN: 978-1-84628-846-3), "Optimal Observation for Cyber-physical Systems"(with Zhen Song, Chellury Sastry and Nazif Tas. Springer, July 2009, ISBN: 978-1-84882-655-7), "Fractional-order Systems and Controls" (with Concepción A. Monje, Blas M. Vinagre, Dingyu Xue and Vicente Feliu, ISBN: 978-1-84996-334-3), and "Optimal Mobile Sensing and Actuation

Strategies in Cyber-physical Systems” (with Christophe Tricaud). His current research interests include autonomous navigation and intelligent control of a team of unmanned ground vehicles, machine vision for control and automation, distributed control systems (MAS-net: mobile actuator-sensor networks), fractional-order control, interval computation, and iterative/repetitive/adaptive learning control. Currently, he serves as an Associate Editor for IEEE Control Systems Society, Conference Editorial Board (CSSCEB). He was also an Associate Editor of ISA Review Board for AACC 's American Control Conference (ACC2005). He has been the Co-Organizer and Instructor of the Tutorial Workshops on “Fractional-order Calculus in Control and Robotics” at IEEE 2002 Conference on Decision and Control (CDC’02), and “Applied Fractional Calculus in Controls and Signal Processing” at CDC’10 and a founding member of the ASME subcommittee on “Fractional Dynamics”.

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