A Half Day Tutorial On

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Regional Analysis of Distributed Parameter Systems: A Tutorial

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The 20th World Congress of the International Federation of Automatic Control |
Toulouse, France | July 9th,2017

https://www.ifac2017.org/workshops-and-tutorials

1. **Title of tutorial:**

   Regional Analysis of Distributed Parameter Systems: A Tutorial
   http://mechatronics.ucmerced.edu/RA-DPS

2. **Outline of the tutorial/workshop (topic and description)**

   Workshop Abstract (why important and why timely and why good for IFAC WC):
   Sensors and actuators are becoming richer and richer in real world systems that are governed by partial differential equations (PDEs), known as distributed parameter systems (DPSs) to well characterize those processes, such as soil moisture process of a crop field, pest or disease spreading process in agriculture lands, crowd evacuation process, and etc. Modeling and control of DPSs are highly dependent on sensor and actuator configurations. The configurations can be one of the 5 cases: pointwise, filament, boundary, zonal, and whole domain for sensors and actuators, respectively which can also be mobile or static, collocated/noncollocated (on the same robotic mobility platform or not), communicating/noncommunicating, resulting 5x5x4x2x4 (800) possible configurations.

   There are cases when the system is not controllable or observable in the whole domain of interest but can be controllable and observable in a subdomain. Thus regional analysis makes more practical sense. Regional sensing and actuation is getting more and more important in this IoT (internet of things), CPS (cyber-physical systems), CHS (cyber-human systems) age with cloud computing and big data movements.

   This tutorial will prepare the IFAC WC audience with 1) *compelling reasons why this research theme is important,* 2) *what are basic concepts and existing results*, and 3) *what are rich future research opportunities*.

   Topics: Saturday July 8th, 2017, 14:00-17:30
   1) 14:00-14:15. Introduction to the Tutorial Workshop (Chen)
   2) 14:15-15:00. Regional analysis of DPSs – 25 years in review (El Jai)
   3) 15:00-15:45. Regional analysis: from parabolic to hyperbolic to bilinear cases (Zerrik)
   4) 15:45-16:00. Break.
   5) 16:00-16:45. Why we should use regional analysis: From MAS-net project to CPS to CHS (Chen)
   6) 16:45-17:30 Regional analysis of fractional order DPSs (Ge)

   More background information:
   ftp://169.236.9.29/El-Jai-collection/ and http://perso.univ-perp.fr/aej/

3. **Duration and sessions**

   Half day, Saturday July 8th, 2017, 14:00-17:30

4. **Description of the intended audience and the expected learning outcomes**

   Graduate students, postdocs, engineers and faculty members dealing with complex engineering and non-engineering systems with rich sensors and rich actuators.

Expected learning outcomes:

1) Basic knowledge on motivations and real world relevance of regional analysis of distributed parameter systems (DPSs) in the context of CPS and CHS.
2) Basic concepts of regional controllability, observability, stability and stabilizability and regional strategic sensing and actuation.
3) The need for generalization of fractional order DPSs and its regional analysis and new research opportunities, with basic working knowledge of fractional calculus based system modeling and control methods.

5. **Desired prerequisite knowledge of the audience**

1) Basic knowledge of finite dimensional system theory.
2) Entry level knowledge of infinite dimensional system theory.

6. **The tutorial speaker(s)**

Professor Abdelhaq EL JAI
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7. **Brief biographies for each tutorial/workshop speaker (no more than 300 words per person)**

Professor Abdelhaq EL JAI received his Bachelor (mathelem) at Lycée Lyautey, Casablanca, Morocco, in June 1967, his license and his MA in Mathematics and Fundamental Applications at the

University Paul Sabatier, Toulouse France respectively in 1970 and 1971. He had DEA and Doctorate 3rd cycle respectively in 1972 and 1973. He had a Doctorate Es-Sciences, prepared at the Laboratory of Automatic and Systems Analysis (LAAS - CNRS), University Paul Sabatier, Toulouse, 1978. He worked and directed the laboratory of Optimal Control, Faculty of Sciences of Rabat and the lab Automatic, IMP-CNRS in Perpignan and finally the laboratory Systems Theory in Perpignan, France. He also stayed as a visiting professor in many institutions and universities worldwide. Professor El Jai research activities cover many aspects in systems theory, focusing on the modeling and analysis of distributed systems through sensors and actuators. Various concepts of regional analysis were introduced and studied. Other unique to distributed systems concepts were introduced. Her interest in modeling distributed systems led him to consider the systems a new approach based on cellular automata. He has written and co-edited twenty books and over one hundred publications or papers in international conferences.

Professor El Hassan Zerrik: received his third cycle Doctorat at University Med V in Rabat in April 1987, then assistant professor at University Moulay Ismail in Meknes and then professor and researcher at the Automatic Laboratory (IMP-CNRS), University of Perpignan, France from 1990 to 1993 where He had prepared a Doctorate Es-Sciences that he defended at University Med V, 1993, and again professor at University Moulay Ismail.Professor Zerrik founded the MACS Laboratory in 1993, and has developed with professor El Jai the concept of regional analysis. He has written many books and published a hundred of papers in the area of systems theory. He is still the head of the MACS Laboratory and the studies Director at the Royal Military Academy in Meknes.

YangQuanChen joined University of California, Merced in summer 2012 with a vision to promote the wide-spread use of low cost scientific data-drones in precision agriculture and environmental monitoring. His unmanned aerial systems (UAS) team at UC Merced has been pursuing research excellence in innovative use of data-drones for crop, water, soil, dust, air, and fire etc. Dr. Chen received Ph.D. from Nanyang Technological University Singapore in 1998. His current areas of research interest include: applied fractional calculus in controls, signal processing and energy informatics; distributed measurement and distributed control of distributed parameter systems using mobile actuator and sensor networks; mechatronics; multi-UAV based cooperative multi-spectral "personal remote sensing" for precision agriculture and environmental monitoring. He is an Associate Editor for IFAC journals of Mechatronics and Control Engineering Practice, Fractional Calculus and Applied Analysis, IET Control Theory and Applications, IEEE Transactions of Control Systems Technology, ISA Transactions and Cogent Engineering (Systems and Control).   He also serves as the Topic-Editor-in-Chief in "Field Robotics" for International Journal of Advanced Robotic Systems (IJARS), a Senior Editor for International Journal of Intelligent and Robotic Systems, and an associate editor for Journal of Intelligent Service Robotics. He was an associate editor for ASME Journal of Dynamical Systems, Measurement and Control (2009-2015) and a Founding Associate Editor for Unmanned Systems (2013-2015). Dr. Chen is a member of ASPRS, AUVSI, AMA, IEEE, ASME, AIAA, and ASEE. He serves as the co-chair for IEEE RAS TC on Aerial Robotics and UAV, IEEE-USA CTAP, and Program Co-chair for ICUAS 2016, Washington, DC, and General Co-Chair for ICUAS 2017, Miami, FL. He can be reached by email: yqchen@ieee.org

Fudong Ge earned his Ph.D. in the College of Information Science and Technology of Donghua University, Shanghai, China in 2016. He joined the MESA Lab of the University of California, Merced in October, 2014 as an Exchange Ph.D. student. He is now an associate professor at the School of Computer Science, China University of Geosciences, Wuhan, Hubei Province, China. His research interests include existence, stability/stabilization of solutions for fractional differential equations; continuous time random walks and anomalous diffusion systems; distributed measurement and distributed optimal control problems in general distributed parameter systems or cyber-physical systems in general form. He can be reached by email: gefd2011@gmail.com