

MICHIGAN STATE UNIVERSITY
Department of Statistics and Probability

A Workshop on Future Directions in Fractional Calculus Research and Applications

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Regional Sensing and Actuation of Fractional Order Distributed Parameter Systems

Abstract

Real world processes are mostly distributed parameter systems (DPS) governed by partial differential equations (PDEs) 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 $5 \times 5 \times 4 \times 2 \times 4$ (800) possible configurations.

It is now widely accepted that, integer order DPS (PDE) is just an approximation for “our own convenience” while the reality is of non-integer order dynamic. Furthermore, 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 seminar will cover motivations, new concepts of regional controllability, regional observability, regional detection of unknown sources, regional stability and regional stabilizability, for time-fractional order diffusion processes with general sensor and actuator configurations. Rich future research opportunities will be briefly introduced.

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