Technical Committee on Distributed Parameter Systems

The modeling and control of distributed parameter systems (DPS), represented by partial differential equations (PDEs) and infinite-dimensional state spaces, have attracted increasing interest and undergone important developments in the past ten years due to two major factors. First, recent technological progress in material sciences, power generation, communication, and distribution networks requires the use of more accurate models involving PDEs for simulation and control design. The system-level formulation, analysis, and control of such phenomena are of high theoretical and practical interest in many engineering fields, such as the control of quantum systems, microelectromechanical systems, smart systems, micro- and nanorobotics, Tokamak-like nuclear reactors, and smart grids for energy generation or distribution, chemical or bio processes, fluid mechanics and fluid structure interactions, and acoustics (see Figure 1). Second, increased computer power has enabled the use of extremely high-order models that are structurally similar to infinite-dimensional dynamical systems represented by PDEs. In the near future, it will become practical to directly consider control design on infinite-dimensional systems using an appropriate choice of a numerical scheme (see Figure 2). These approaches will enable very complex control problems (such as those involving PDEs with variable spatial domain) to be considered.

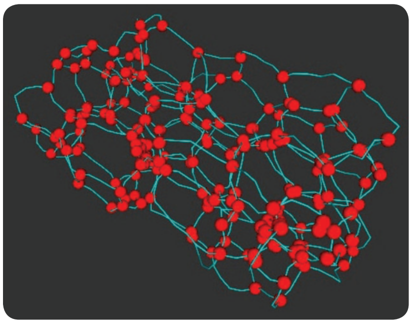

FIGURE 1 The modeling and control of complex partial differential equation networks for the catalytic and acoustic foams ANR-DFG INFIDHEM project (with the authorization of DigitalFoam ANR-AA-IDEX-007-02 PALSE/2013/21).

The IEEE Control Systems Society (CSS) Technical Committee on Distributed Parameter Systems (TC-DPS) brings together researchers from both the system control theory and control engineering communities who work on the modeling, analysis, and control of DPS. TC-DPS aims to promote activities within the field of DPS (infinite-dimensional systems modeled by delay or PDEs), fostering development of both basic scientific methodologies and emerging applications. Even if the modeling and control of systems governed by PDEs are the subjects of an ongoing research activity from both the control system theory and control engineering communities, within this TC, they obey the same system-oriented philosophy and cover a wide theoretical spectrum ranging from functional analysis, to algebra, operator theory, and numerical analysis. More precisely, research developed within the TC aims to prove the existence of solutions, establish stability and controllability properties, determine optimal sensor locations, and derive efficient control design procedures for systems governed by PDEs. It also focuses on analyzing the numerical approximations of infinite-dimensional systems

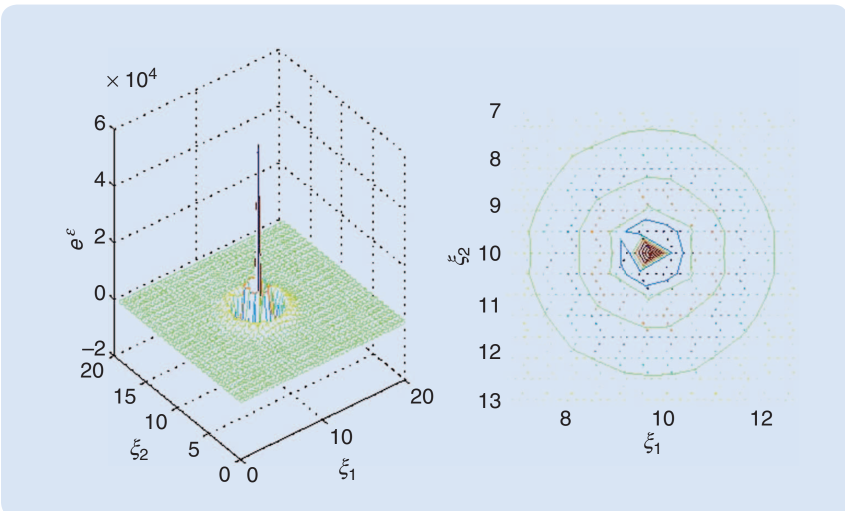

FIGURE 2 The isotropy-preserving numerical approximation in time and space of the two-dimensional wave equation.

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FIGURE 3 The Joint International Federation of Automatic Control/IEEE Workshop on Control of Systems Governed by Partial Differential Equations, Bertinoro, Italy, 2016.

suitable for both simulation and real-time implementation.

Although the problem of the control of a system of coupled nonlinear PDEs is generally intractable, significant progress has been achieved for well-defined classes of nonlinearities or by restricting the class of infinite-dimensional systems to those arising from physical models. In the nonlinear case, studies are attained individually by case, with the existence of solutions being derived from the perturbation of the associated linearized systems and stability proven using the appropriate physically motivated (or generic) Lyapunov functions and Lasalle's invariant principle. For linear infinite-dimensional systems, a rich theory has been built that uses dissipativity properties such as energy balance equations (including energy flows with the environment) to obtain basic stability and stabilizability. More constructive control design methods (such as backstepping, energy-shaping, or flatness-based methods) are the subject of intense research to address the mathematical and numerical complexity.

TC-DPS has experienced increased activity in the past ten years, regularly organizing invited sessions at conferences such as the IEEE Conference on Decision and Control, American Control Conference, European Control Conference, International Federation of Automatic Control (IFAC) Symposium on Nonlinear Control Systems, IFAC Lagrangian and Hamiltonian Methods for Nonlinear Control, and IFAC Thermodynamic Foundations of Mathematical System Theory. Invited sessions have also been organized in mathematically oriented conferences such as the International Symposium on Mathematical Theory of Networks and Systems and the Society for Industrial and Applied Mathematics Control Conference. TC-DPS, in collaboration with the IFAC TC 2.6, takes an active part in the organization and promotion of two regular workshops: the Workshop on Control of Distributed Parameter Systems and the Joint IEEE/IFAC Workshop on Control of Systems Governed by Partial Differential Equations (Figure 3). TC-DPS is also involved in the organization of international doctoral courses (for example, modules within the International Graduate School on Control), training, and summer school sessions (IEEE/IFAC Summer School, jointly organized with IFAC) for Ph.D. students.

TC-DPS's activities have been supported by numerous funding agencies such as EC, ANR, DFG, and industrial partners through major projects: ERC DYCON, ITN CONFLEX, PRC HAMECMOPSYS, and INFIDHEM (see the TC-DPS website for an updated list).

Information on future events and related job offers can be found at http://distributed-parameter-systems.ieeecss.org/. Any CSS member is more than welcome to join the TC and take on an active role in its activities. Send me an e-mail (legorrec@femto-st.fr) with your contact information to receive information on upcoming events.

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