IEEE Control Systems Society Technical Committee on Distributed Parameter Systems

Distributed parameter systems (DPSs) are encountered frequently in a multitude of engineering applications involving control of fluid flows and temperature profiles and analysis of flexible and vibrating physical systems. In addition, DPSs have become essential in novel areas involving quantum systems, traffic flow control, information science, neuroscience and neuronal networks, and even machine learning. In mathematical terms, DPSs are typically governed by partial differential equations (PDEs) and partial integro-differential equations (PIDEs), but they may also include couplings with ordinary or delay differential equations. The Technical Committee (TC) on DPSs focuses on developing and fostering methods for modeling, analysis, control, and estimation for this class of dynamic systems (Figure 1).

TC activities range from mathematical control theory involving functional analysis and operator theory to applications of DPS control involving suitable numerical approximation schemes, but remain centered around the same system-oriented philosophy. Research aims at proving solutions existence or verifying stability/stabilizability or controllability/observability properties. The latter topics also lead naturally to the design of optimal actuator and sensor placement, which (unlike finite-dimensional systems) requires consideration of the problem's spatial domain. Major progress has been made to address stability by exploiting physics-inspired relationships and properties. A rich theory has been built upon the dissipativity/passivity concept and the analysis of energy flows and energy exchange with the system's environment. This also supports the construction of suitable Lyapunov functionals to be used for system analysis and control design. These activities are accompanied by more constructive design methods, such as backstepping, flatness, or energy-shaping for stabilization and tracking control. Extensions of these concepts and methods to nonlinear PDEs and PIDEs are a subject of intense research activities involving many of the TC members.

Driven by the increase in computational power the numerical approximation of highly complex, coupled, multiphysics problems evolving on high-dimensional or time-varying spatial domains has become tractable. In combination with model-order reduction techniques to extract the most relevant information of the large-scale system dynamics, efficient implementations (for example, of optimal control or state estimation) have been proposed and evaluated in simulations (Figure 1).

In this spirit, the TC has a strong affiliation to applied mathematics, system and control theory, and engineering, which is also reflected by the current 72 TC members who actively promote DPSs as well as their analysis and control.

TC MEETINGS AND ACTIVITIES

The TC takes an active part in the organization and the promotion of the Workshop on Control of Distributed Parameter Systems (CDPS) and, in close collaboration with the IFAC TC 2.6 on DPSs, has set up a joint triennial IFAC Workshop on Control of Systems Governed by Partial Differential Equations (CPDE). The fourth edition of CPDE, cosponsored by IEEE Control Systems Society (CSS), was organized in Kiel, Germany from 4 to 9 September 2022. The three-day, in-person conference included 36 research presentations and

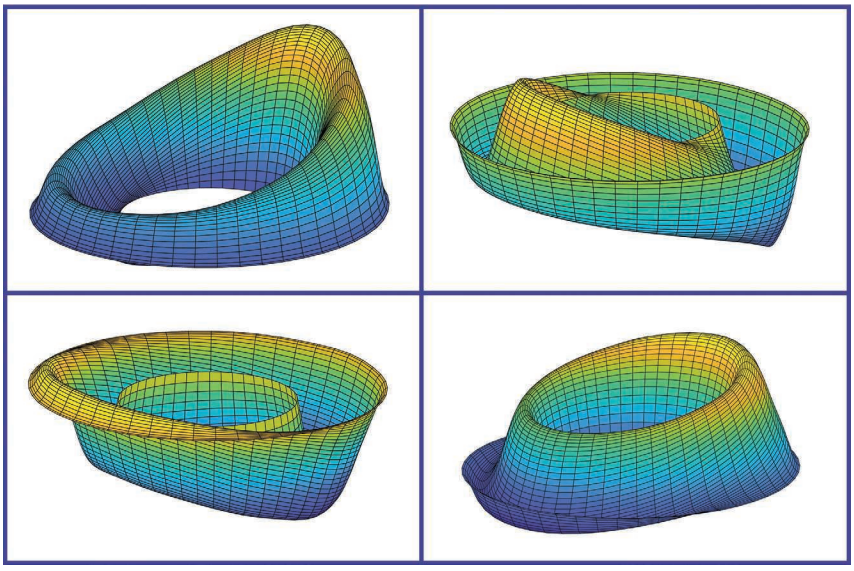

FIGURE 1 Boundary control of a 2D wave profile.

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five plenary lectures given by Weiwei Hu, Birgit Jacob, Igor Mesic, Christophe Prieur, and Lassi Paunonen, covering various aspects of the control of DPSs and PDEs. The workshop was well attended, with a total of 58 participants, leading to lively and constructive discussions in each session and plenary (Figure 2). The conference was preceded by a three-day summer school with the title "A Practical Introduction to Control, Numerics. and Machine Learning," lectured by Enrique Zuazua and Daniël Veldman.

The TC meets regularly at the main IEEE CSS-sponsored events. The last two meetings were held at the IEEE Conference on Decision and Control (CDC) 2021 (virtual conference) and CDC 2022 (Cancún, Mexico). The 2021 meeting was held as a video conference and the 2022 meeting was organized in hybrid form, with roughly 20 in-person participants. After the return to in-person conferences, the discussion at the 2022 discussion related to the past and future TC activities was lively and relaxed. The future meetings will also continue to use the hybrid format to facilitate wider participation. The TC activities involve the regular organization of invited sessions in international control conferences and workshops, including the IEEE CDC (six sessions in 2021 and four in 2022), the American Control Conference (four in 2022), and the International Symposium on Mathematical Theory of Networks and Systems 2022 (six sessions). The TC is also involved in the organization of international doctoral courses: for example, in terms of modules within the International Graduate School on Control.

AWARDS AND RECOGNITIONS

In 2022, the TC organized the awarding of the IEEE TC DPS Outstanding Student Paper Prize, which is given to a student who is the primary author of a paper presented at the CDC and is also a TC member. The selection committee received excellent nominations, which were carefully evaluated and discussed during the selection process. The 2021 IEEE TC DPS Outstanding Student Paper Prize was awarded to Anthony Hastir for his paper entitled "Local Exponential Stabilization of Nonlinear Infinite-Dimensional Systems" (coauthors Joseph J. Winkin and Denis Dochain), presented at the 2021 CDC. This was the second time in history that the prize was awarded.

In 2022, TC member Miroslav Krstic was awarded the prestigious IEEE Control Systems Society Bode Lecture Prize. In the same year, Prof. Krstic was also awarded the IFAC TC 2.6 Award on Control of DPS in memory of Ruth Curtain. This award was handed to the recipient during the CPDE 2022 Workshop in Kiel, Germany (Figure 3).

TC Member Enrique Zuazua was awarded the 2022 Society for Industrial and Applied Mathematics W.T. and Idalia Reid Prize for fundamental theoretical and computational contributions to the control, numerics, and analysis of nonlinear PDEs and multiphysical systems with impactful scientific and industrial applications.

From 2023 to 2027, several TC members will coordinate the Marie Sklodowska-Curie Actions Doctoral Network "ModConFlex: Modeling and control of flexible structures interacting with fluids," coordinated by Prof. Birgit Jacob (Wuppertal, Germany). Research activities of TC members have also been supported by numerous

FIGURE 2 Attendees of IFAC CPDE 2022 in Kiel, Germany.

FIGURE 3 Miroslav Krstic receiving the IFAC TC 2.6 Award on Control of DPS in memory of Ruth Curtain. From left to right: Yann Le Gorrec (International Program Committee cochair of IFAC CPDE), Hans Zwart (chair of Award's Committee), Miroslav Krstic, and Thomas Meurer (TC chair).

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other funding agencies, such as the European Commission, Agence Nationale de la Recherce (ANR), Deutsche Forschungsgemeinschaft (DFG), and industrial partners through major projects, for example, the European Research Council (ERC) PortWings, ERC DyCon, Innovative Training Network ConFlex, and ANR-DFG INFIDHEM (see the TC webpage for an updated list).

GETTING INVOLVED

To facilitate easier sharing of information regarding open positions in the field of DPS control, the TC launched a dedicated website DPS Jobs (http://dps-jobs.org) in early 2023. More information on future events and additional material can be found on the TC website https://ieeecss.org/tc/distributed-parameter-systems.

Any CSS member is more than welcome to join the TC and take an active part in its activities; just send me an e-mail (lassi.paunonen@tuni.fi) with your contact information to receive updates on forthcoming events.

Lassi Paunonen
Technical Committee chair from 2023
Thomas Meurer
Technical Committee chair from 2020 to 2022

Networks and Communication Systems

The IEEE Control Systems Society Technical Committee (CSS TC) on Networks and Communication Systems aims to promote communication among researchers active in the area of control of network systems with a broad spectrum of applications, including communication networks, transportation and energy systems, social and economic networks, financial systems, and biological networks. The TC on Networks and Communication Systems provides a forum to discuss new research directions on modeling, analysis, optimization, and control of emerging networks, both with social and technological aspects. It allows members to coordinate activities, including organization of new workshops and several invited sessions on networks at the IEEE Conference on Decision and Control (CDC) and other major conferences. Another important objective is to increase CSS publications that could provide a visible outlet for high-quality research in this area. Over the last few years, this TC has grown to more than 110 members, including around 30 students and postdocs. It is chaired by Giacomo Como and is organized into eight working groups: "Control of Network Systems" (chaired by Paolo Frasca), "Information Networks and Control" (chaired by Serdar Yüksel), "Networked Sensing and Sensor Networks" (chaired by Venkatesh Saligrama), "Optimization and Game Theoretic Methods in Networks" (chaired by Francesca Parise), "Cybersecurity and Privacy" (chaired by Yilin Mo), "Infrastructure Networks" (chaired by Ketan Savla), "Internet of Things" (chaired by Rolf Findeisen), and "Learning, Dynamics and Behaviours in Social Systems" (chaired by Chiara Ravazzi).

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RECENT ACTIVITIES

Over the past months, our TC has been involved in the organization of several scientific initiatives. In particular, our working groups have been actively organizing several invited sessions at the 61st CDC that was held in Cancún, Mexico, from 6 to 9 December 2022, including those on "Resilience and Robustness in Large-Scale Networked Systems," "Networked CPS Resilience," "Event-Triggered Control," "Event-Triggered Control for Multi-Vehicle, Multi-Robot, and Multi-Agent Systems," "Learning and Resilience in Event-Triggered Control," "Modeling, Estimation, and Control of Epidemic Systems," and "Dynamics in Complex Networks: Estimation, Analysis, Control."

Our TC has also contributed to the organization of the half-day workshop "Challenges in Robust and Complex Systems" [1] that was held at the Department of Mathematical Sciences "G.L. Lagrange" of Politecnico di Torino, Torino, Italy, within the first Control Systems CSS day on 20 October 2022. A four-day workshop on "Algorithmic Game Theory, Mechanism Design, and