Technical Committee on Hybrid Systems

Cyberphysical systems (CPSs) are complex systems resulting from the intricate interaction between digital computational components and the physical plants. Within CPSs, digital components monitor and adjust several physical variables (such as temperature, velocity, pressure, and density) through feedback loops where physical processes affect computation and vice versa. With the current technological advances in computational devices, CPSs are becoming more ubiquitous in many safety-critical applications, including automotive, aerospace, transportation systems, chemical process, critical infrastructure, energy, robotics, and health care. These are all examples of hybrid systems whose models are inherently heterogeneous: discrete systems modeling computational parts and (stochastic) differential equations modeling continuous physical processes.

The focus of the IEEE Control Systems Society (CSS) Technical Committee on Hybrid Systems (TC-HS) is to promote research and education on hybrid systems. The TC is dedicated to providing scientific forums, summer schools, invited sessions within different conferences, workshops for technical discussion, and online information (such as Wikipedia) to researchers and students interested in the field of hybrid systems and its applications. TC-HS currently has 97 members. The current TC chair is Majid Zamani (University of Colorado Boulder), and the cochairs are Manuel Mazo Jr. (Delft University of Technology, The Netherlands), Sadegh Soudjani (Newcastle University, United Kingdom), and Jana Tumova (KTH Royal Institute of Technology, Sweden). This column summarizes the main activities of the TC during 2019 and early 2020.

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ACTIVITIES

The TC meets annually at IEEE sponsored conferences. TC meetings were held at the 2018 IEEE Conference on Decision and Control (CDC) in Miami Beach, Florida; the 2019 American Control Conference (ACC) in Philadelphia, Pennsylvania; and the 2019 IEEE CDC in Nice, France. The first TC-HS meeting of this year is scheduled at the ACC in Denver, Colorado.

The TC helps organize invited sessions and workshops at many conferences. During 2019, members of the TC organized invited sessions at the ACC and CDC. Sandra Hirche (Technical University of Munich, Germany), John Baras (University of Maryland, College Park), Klaus Wehrle (RWTH Aachen University, Germany), and Mohammad Mamduhi (KTH Royal Institute of Technology, Sweden) organized a one-day workshop "Control and Networking in Cyber-Physical Systems," which took place June 25, 2019 during the European Control Conference. Mahnoosh Alizadeh (University of California, Santa Barbara), Sam Coogan (Georgia Institute of Technology, Atlanta), Ketan Savla (University of Southern California, Los Angeles), Dan Work (Vanderbilt University, Nashville, Tennessee), and Vijay Gupta (University of Notre Dame, Indiana) organized a day and a half workshop at ACC 2019, "Control for Networked Transportation Systems," on July 8–9. During CDC 2019, Berk Altın and

The members of the IEEE Control Systems Society Technical Committee on Hybrid Systems during the Conference on Decision and Control 2019 in Nice, France.

Ricardo Sanfelice (University of California, Santa Cruz) organized a one-day workshop, "Model Predictive Control of Hybrid Dynamical Systems." Finally, Maria Laura Delle Monache (Inria Grenoble Rhône, Alpes, France), Jonathan Sprinkle (University of Arizona, Tucson), Ramanarayan Vasudevan (University of Michigan, Ann Arbor), and Daniel Work (Vanderbilt University) organized a tutorial session, "Autonomous Vehicles and Traffic Control in Mixed Autonomy Environments," during CDC 2019. Also at CDC 2019, a thematic TC meeting, "Open Problems in Hybrid Systems and Control," was organized by TC members Alessandro Giua, Francesco Ferrante, Maurice Heemels, Necmiye Ozay, Ricardo Sanfelice, Sze Yong, and Luca Zaccarian.

Since CDC 2018 (and spearheaded by TC-HS member Raphael Jungers), it has become a tradition now that student members of TC-HS meet for a social event during the CDC and ACC. The program is very simple; students meet at a nearby bar or restaurant to talk about their professional and social lives. This activity creates a unique opportunity for students working on hybrid systems to socialize and build relationships between research teams within the field.

Since 2018, TC-HS has been part of the organization of the Northern California Control Workshop. In a kickoff at University of California (UC) Santa Cruz in 2018, the second edition of this workshop took place at UC Berkeley in April 2019. Following the model of the very successful Southern California Control Workshop, this annual event provides a forum to bring together students, postdocs, and faculty from various universities in the Northern California region (as well as representatives from industry) working in the broad area of systems and control to share knowledge and build new connections.

TC-HS strongly believes that a cornerstone of our research is the development of software tools that can both support research and facilitate the transition of results from academia to practice. In line with our belief, the TC (led by Manuel Mazo Jr.) has made an effort to compile as many of these tools that are produced in our community or relevant to our field in a single location (https://bit.ly/3acZ4Be). We have classified tools as pertaining to three main classes: 1) modeling and identification, 2) verification and analysis, and 3) synthesis. The first class comprises tools focused on the construction of hybrid systems models for analysis, design, and simulation. It also includes tools for the system identification of hybrid models, such as the construction of models from data. Under the second class, we have collected tools that allow researchers and practitioners to prove or verify properties of hybrid systems. The final category includes tools that automate the design of controllers for, or in the form of, hybrid systems. An additional list of tools is included in the repository-collecting utilities to help implement controllers on field-programmable gate arrays, compress the size of controllers, and port models between tools. We invite all members of our community to check the repository and inform us of any missing tool that should be included, along with any newly released tools, so that the list can be as updated and comprehensive as possible.

JOINING THE TECHNICAL COMMITTEE

If you are interested in joining the TC, please send an email to the TC chair, Prof. Majid Zamani, at majid.zamani@colorado.edu, asking to be included in the database. Once registered, you will be added to the TC mailing list.

Majid Zamani

IEEE CSS

The Fifth Pillar

I call the fifth pillar Regression, after Galton' s revelation of 1885, explained in terms of the bivariate normal distribution. Glaton arrived at this by attempting to devise a mathematical framework for Charles Darwin's theory of natural selection, overcoming what appeared to Galton to be an intrinsic contradiction in the theory: selection required increasing diversity, in contradiction to the appearance of the population stability needed for the definition of species.

— Stephen Stigler, *The Seven Pillars of Statistical Wisdom*, Harvard University Press, 2016.