Post-Conference Workshops

The CDC 2012 is offering seven workshops on Friday December 14, 2012. The workshops will be offered based on viable attendance. The CDC 2012 reserves the right to cancel non-viable workshops. In the event of a cancellation, the attendees will be given the option of registering for another workshop, or requesting a refund.

**STUDENTS:** The Control Systems Society is providing support for an initiative to allow students, who register for the conference, to also register for a workshop for a non-refundable $5 fee. The number of students per workshop will be limited and registration will be provided on a first-come first-served basis. Early registration through [https://www.paperplaza.net/registration](https://www.paperplaza.net/registration) is highly recommended.

Workshops will start at 8:30AM, with a lunch break from 12:00-1:00PM.

**List of workshops offered (dependent on attendance):**

**Title:** Predictive Control for Embedded Systems: State of the Art and Future Challenges

**Organizers:** C.N. Jones (EPFL, Switzerland), R. Findeisen (Otto-von-Guericke Universität, Magdeburg)

**Contributors:** M. Diehl, Sebastien Gros (KU Leuven, Belgium), R. Findeisen, M. Kögel, P. Zometa (Otto-von-Guericke Universität, Magdeburg), C.N. Jones (EPFL, Switzerland), E. Kerrigan (Imperial College, UK), M. Möniggmann (Bochum University, Germany), G. Papafothiou (ABB, Switzerland)

**Abstract:** In recent years there has been a strong interest in opening up new application fields for predictive control, with a main focus on systems requiring fast sampling rates, but that are implemented on computationally limited, or low cost embedded hardware platforms. For these applications, efficient, real-time and accurate solutions of the underlying optimization problem are required, in order to guarantee stability, performance, and satisfaction of constraints. Providing solutions to these challenges requires the close intertwining of methods from control and systems theory, computer science as well as numerical analysis.

The purpose of this workshop is to provide an introduction and overview of the current state of the art of predictive control for embedded systems, as well as an outlook toward current and future challenges. After a basic introduction into the field of predictive control on embedded systems, internationally well-recognized researchers in the field will outline the major advances over the last years with a special focus on the interplay between:

- efficient real-time feasible synthesis and solution strategies;
- important system theoretic results with respect to stability and robustness;
- key implementation aspects, such as numerical precision versus quantization, and automatic code generation.

The course is split into three parts: an introductory segment, including background information; a section focusing on the interplay between efficiency, implementation properties, numerical methods, and system theoretic properties; and will end with an application study. More information is available at: [http://ifatwww.et.uni-magdeburg.de/syst/cdc2012](http://ifatwww.et.uni-magdeburg.de/syst/cdc2012)
Title: Control Architecture for Discrete-Event Dynamic Systems: From Monolithic to Distributed and to Heterarchical

Organizers: Kai Cai (University of Toronto, Canada), Rong Su (Nanyang Technological University, Singapore), Klaus Werner Schmidt (Cankaya University, Ankara), Lei Feng (KTH Royal Institute of Technology, Sweden)

Abstract: From a system-theoretic point of view, a control architecture is an organization of system-wide information feedback for conversion to actionable decision-making. Familiar architectures are monolithic (or centralized), heterarchical (some combination of hierarchical and decentralized), and distributed (purely flat, or leaderless). In his celebrated 1962 essay on the “architecture of complexity” Herbert Simon argued that many complex physical, biological, and social systems are organized in sophisticated architectures. Likewise, the control of complex engineering systems calls for well-designed architectures. Starting from the seminal work “theory of multi-level hierarchical systems” by Mesarovic, Macko and Takahara, the systems control community has made much progress in understanding and designing sophisticated architectures, which is key to bridging systems control theory to large-scale engineering practice.

This workshop is an attempt to present such progress in supervisory control of discrete-event systems modeled by automata. Stimulated by the twin goals of reducing computational effort of control synthesis and improving comprehensibility of control logic, the DES literature has witnessed a surge of heterarchical and distributed architectures designed for large interconnected systems. This workshop attempts to bring together recent developments of key approaches for systematically synthesizing these architectures, and present the results in a unified, tutorial manner. We will start with a detailed survey of existing control synthesis methods for large complex DES. Then we focus on describing decomposition-aggregation based on a structural approach to constructing heterarchical and distributed control architectures, the key being creating model abstractions effective in hiding part of the underlying system dynamics irrelevant to control. We will present in a coherent style recently developed key notions and properties of such abstractions, as well as efficient algorithms and software tools for their computation. Based on these results, we further introduce a top-down localization approach that decomposes a synthesized heterarchical architecture into a purely distributed architecture where component agents are self-driven and cooperative. Finally, we will address a range of applications which points to practical implementation of heterarchical and distributed architectures, and discuss future core problems of control architecture.
Title: Identification, Analysis and Design of Biological Networks

Organizers: Elisa Franco (University of California at Riverside), Gabriele Lillacci (ETH Zürich), Abhyudai Singh (University of Delaware), Brian Munsky (Los Alamos National Laboratory)

Additional Participants: David Angeli (Imperial College London), Domitilla Del Vecchio (Massachusetts Institute of Technology), Eric Klavins (University of Washington)

Abstract: Systematic engineering of molecular systems is a very difficult challenge, which is severely impeded by factors such as cross-talk, stochasticity and parametric uncertainty. Control-theoretic tools for systems identification, analysis, and design promise to help streamline improvements in biological technologies that range from medical advances to biofuel production and molecular robotics. On one hand, researchers must be able to identify the structure and dynamics of natural biological circuits in order to re-engineer and optimize these processes to accomplish a specified function. On the other hand, the bottom-up design of molecular networks requires the development of new methods, which in many cases can be borrowed and adapted from standard engineering practices in other fields. We argue that future generations of molecular and biological engineers should be trained in numerous aspects of these top-down and bottom-up approaches. The main objective of this workshop is to provide an overview of successful research directions in the areas of biochemical network identification and design. In terms of theoretical analyses, both deterministic and stochastic approaches will be considered. We will also introduce recent experimental capabilities that have reinvented biology as an engineering discipline. In this context, our workshop will stress the importance of tight integration between theoretical and experimental research efforts. With this in mind, we have carefully selected speakers whose scientific efforts lie at the intersection of experimental and computational systems biology.

Title: Control and Power Electronics for Renewable Energy and Smart Grid Integration

Organizers: Qing-Chang Zhong

Abstract: Energy and sustainability are now on the top agenda of many governments. Smart grids have become one of the main enablers to address energy and sustainability issues. Renewable energy, distributed generation, hybrid electrical vehicles, more-electric aircraft, all-electric ships, smart grids etc. will become more and more popular. Arguably, the integration of renewable and distributed energy sources, energy storage and demand-side resources into smart grids, often via inverters, is the largest “new frontier” for smart grid advancements. Control and power electronics are two key enabling technologies for this. The proposed workshop intends to cover the latest advancements in control and power electronics for renewable energy and smart grid integration. Various control problems around inverters, e.g. power quality issues, grid-connection and power flow control, synchronisation and parallel operation of inverters, will be addressed with innovative concepts such as synchconverters (inverters that mimic synchronous generators), C-inverters (inverters with capacitive output impedances), robust droop control, harmonic droop control, sinusoid-locked loops etc. It will help researchers who want to move into the area of smart grids establish a solid technical foundation for modeling, optimization and control of smart grids. Most of the artful control strategies to be presented will be demonstrated with experimental results and, hence, the workshop will also help practitioners understand how advanced control strategies could improve system performance. The workshop also provides an excellent opportunity for researchers, PhD students and postdoctoral fellows who work in the area to get familiar with the latest developments.
Title: Guidance, Navigation and Control Applications in the Aerospace Industry Current Problems and Modern Solutions - A Workshop Sponsored by the IEEE Technical Committee on Aerospace Controls

Organizers: Richard A. Hull (United Technologies Aerospace Systems), Kevin A. Wise (Boeing Company), D. Brett Ridgely (Raytheon Missile Systems), James M. Buffington (Lockheed Martin), Zihua Qu (University of Central Florida), Naira Hovakimyan (University of Illinois at Urbana-Champaign), Gokhan Inalhan (Istanbul Technical University), Richard Scott Erwin (Air Force Research Laboratory), Clinton Plaisted (a.i. solutions / NASA Launch Services Program)

Additional Participants: Michael Wolf (NASA Launch Services Program, KSC), Daniel Kirk, Hector Gutierrez, Brian Wise and Bartel van der Veek (Florida Institute of Technology), Eduardo Garcia Gonzales (CRIDA/UPM), Emre Koyuncu (Istanbul Technical University), Mark Karpenko (Naval Postgraduate School), Brian Hamilton and Brett McMickel (Honeywell Defense and Space), Sagar Bhatt (The Charles Stark Draper Laboratory, Inc.), Frederick Leve (Air Force Research Laboratory), Enric Xargay (University of Illinois at Urbana-Champaign), Jeff Harris (Lockheed Martin)

Abstract: This workshop will focus on current problems in guidance, navigation and control encountered in the aerospace industry with an emphasis on the application of modern control solutions. The workshop will be presented by leading GNC experts from industry, government and academia that are involved in on-going research and development efforts. This workshop is intended for students and professors in search of current applications in need of solutions as well as industry and government professionals in search of potential solutions from academia and adjacent branches of the aerospace industry. This workshop is sponsored and presented by members of the IEEE Technical Committee on Aerospace Controls and their affiliates and will cover current industry topics in GNC for manned and unmanned aircraft (UAV’s), guided missiles, space launch vehicles, satellites, and gun launched guided projectiles. Although no classified or restricted information will be presented, the workshop authors will present a brief introduction to the types of systems they study, unclassified but representative models for GNC analysis, and comparisons of current GNC algorithm solutions and methods. The workshop will offer opportunities for questions and answers, and provide an open forum for discussion of applications for current theoretical advances and potential enabling technologies. The list of topics presented will include:

- “Novel Guidance Solutions and Nonlinear Control Issues in Gun Launched Guided Projectiles”
- “Co-Design of Communication Topology and Networked Control with Application to Formation Control”
- “Robust and Adaptive Control Methods for Unstable Uncertain UAV Platforms”
- “Time-Critical Cooperative Path-Following Control of Multiple UAVs”
- “Advanced Flight Control of High Performance Missiles – The Challenge of Robust Affordable Precision”
- “F-35B Control Law Development”
- “L1 Adaptive Control: Technology Transition and Experimental Results”
- “Application of Pseudospectral Optimal Control to the Shortest-Time Maneuvering For Spacecraft Attitude Control Systems”
- “Aircraft 4D Trajectory Management and Control for the Next Generation Air Traffic Management Systems”
- “Modern Control of Flexible Modes in Launch Vehicles using Fiber Optic Sensors”
Title: Control Systems in the Open World: Novel Mathematical Representations for Interaction
Organizers: Ruzena Bajcsy (University of California, Berkeley, USA), Sam Burden (University of California, Berkeley, USA), Humberto Gonzalez (Washington University in St. Louis, USA), S. Shankar Sastry (University of California, Berkeley, USA), Ramanarayan Vasudevan (Massachusetts Institute of Technology, USA).

Additional Participants: Daniel E. Koditschek (University of Pennsylvania, USA), Romeo Ortega (Laboratoire de Signaux et Systemes, SUPELEC, France), Stuart Russell (University of California, Berkeley, USA), Stefano Soatto (University of California, Los Angeles, USA).

Abstract: A control system embedded in a dynamically-evolving environment requires a representation of its world that is tailored to its control objective and that can accommodate varying numbers of external agents possessing unknown dynamics. For instance, a fully autonomous humanoid robot running errands in a grocery store needs to identify and classify inanimate objects, perform inference over its observations, and interact with mobile human and non-human entities. From a sensing perspective, the representation of an object must be informed both by the control objective and by the ability to actively refine observations via control action. From an inference perspective, the true number of external agents and the relationships between them cannot be assumed known a priori and hence must be estimated by observing the consequences of control action. From a control perspective, dynamical models of interacting entities must be obtained compositionally rather than constructed on a case-by-case basis. The purpose of this workshop is to bring together researchers from robotics, sensing, statistical inference, and control theory to discuss recent advances in the mathematical representation of perception, interaction, and inference in dynamic environments.

Title: Robust and Stochastic Control Methods for Sustainable Engineering
Organizers: Anil Aswani (University of California, Berkeley, USA) and Claire Tomlin (University of California, Berkeley, USA)

Additional Participants: Hamsa Balakrishnan (MIT), Alexandre Bayen (UC Berkeley), Panagiotis Christofides (UCLA), John Doyle (Caltech), Zico Kolter (MIT), Jinfeng Liu (U. Alberta), John Lygeros (ETH Zurich), Rahul Mangharam (UPenn), Ram Rajagopal (Stanford), Bruno Sinopoli (CMU), Russ Tedrake (MIT)

Abstract: For a variety of social and economic reasons, designing engineered systems to ensure their operation in a sustainable manner is becoming increasingly important. The focus of the workshop will be on the development and application of control methods to address societal problems related to energy efficiency and pollution reduction in both small- and large-scale systems. One key challenge to achieving improvements in the sustainability of these systems is being able to handle their fundamentally inherent uncertainties. This necessitates the use of robust, stochastic, and adaptive control methods.

The workshop will broadly cover new control methods that have been developed in order to improve the operation of specific systems. Within buildings, variations in occupancy negatively impact the energy characteristics of automation systems; coupling control methods with scheduling and statistical adaptation can reduce average and peak energy usage. Wind turbines can also benefit from such techniques. At the larger scale, the integration of renewable energy into the smart grid may benefit from the use of stochastic and distributed control methods. Similarly, reductions in the pollution and energy consumption of transportation networks are possible by designing infrastructure to better handle the congestion characteristics found in these systems.