SPECIAL SESSIONS

In addition to the main technical program, the conference includes lunch-time and afternoon special sessions on industry, education, emerging topics, and funding opportunities.

WEDNESDAY NOON SPECIAL SESSIONS

An Overview of NSF Programs

Sponsor: **National Science Foundation**
Time: 12:00PM – 1:30 PM, Wednesday, July 1, 2020
Location: Denver
Organizer: Dr. Irina Dolinskaya

The National Science Foundation (NSF) offers a number of funding opportunities for investigators working in the field of controls, both within the disciplinary programs in Engineering and other directorates, and through cross-cutting initiatives that are foundation-wide. This presentation will describe opportunities that are relevant to the robotics, dynamics and controls communities. The presentation will also describe programs targeted toward junior investigators, as well as guidelines for proposal preparation and NSF's Intellectual Merit and Broader Impacts criteria. Question-and-answer session will follow the presentation.

Speakers:

Dr. Kishan Baheti handles the areas of Control and Sensor Networks in the Power, Controls and Adaptive Networks (PCAN) Program in ECS. Dr. Baheti received the B.S. and M.S. in Electrical Engineering in India from VRCE Nagpur, and from BITS Pilani, respectively. In 1970, he came to USA and received M.S. in Information and Computer Science from University of Oklahoma and Ph.D. in Electrical and Computer Engineering from Oregon State University. In 1976, Dr. Baheti joined the Control Engineering Laboratory of GE Corporate Research and Development Center in Schenectady, NY. His work focused on advanced multivariable control for jet engines, signal and image processing systems, computer- aided control system design, vision-based robots for precision welding, model-based fault identification and parallel implementation of Kalman filters. Dr. Baheti and his colleagues received IR-100 award for robotic welding vision system. He has organized a series of educational workshops for GE engineers that resulted in innovative product developments and contributed to enhance university collaborations with GE business divisions. In 1989, Dr.Baheti joined NSF as a Program Director in the Division of Electrical and Communications Systems. His contributions include the development of NSF initiatives on "Combined Research and Curriculum Development", "Semiconductor Manufacturing", and NSF/EPRI Initiative on "Intelligent Control". He was instrumental in the development of NSF Initiative on "Research Experience for Teachers" to involve middle and high school teachers in engineering research that can be transferred to pre-college classrooms. Recently he is involved in networked control systems, sensor and actuator networks, imaging and computational video, micro and nano systems, medical robotics, science of learning, and dynamics and control of biological and medical systems. He has served as associate editor for IEEE Transactions on Automatic Control, member of the Control Systems Board of Governors, chair for Public Information Committee, and awards chair for the American Automatic

Control Council (AACC). He received "Distinguished Member Award" from the IEEE Control Systems Society. In 1997, he was elected a Fellow of IEEE.

Dr. Jordan Berg is Program Director in the Division of Civil, Mechanical, and Manufacturing Innovation (CMMI), in the Engineering Directorate (ENG) of the US National Science Foundation (NSF). He is Emeritus Professor of Mechanical Engineering at Texas Tech University, where he served as Co- Director of the Nano Tech Center, and Associate Director of the DISCO (Dynamic Intelligent Systems, Control and Optimization) group. His research interests are in mechatronics, nonlinear control, and robotics. He received B.S.E. and M.S.E. degrees in Mechanical and Aerospace Engineering from Princeton University in 1981 and 1984, respectively. For several years he was an Attitude Control Analyst with RCA Astro-Electronics in East Windsor, NJ. He received a Ph. D. in Mechanical Engineering and an M. S. in Mathematics from Drexel University in 1992. He was a postdoctoral researcher at USAF Wright Laboratories in Dayton, OH, and at the Institute for Mathematics and its Applications in Minneapolis, MN. He has held numerous leadership positions, including Associate Editor of the ASME/IEEE Transactions on Mechatronics, the ASME Journal of Dynamic Systems, Measurement, and Control, and the IEEE Transactions on Automatic Control. He was Program Chair of the 2014 ASME Dynamic Systems and Control Conference, General Chair of the 2016 IEEE International Conference on Advanced Intelligent Mechatronics, and General Chair of the 2018 American Control Conference. He is a member of the Executive Committee of the ASME Dynamic Systems and Control Division. In 2008 he spent seven months in Sri Lanka as a Fulbright Scholar. He was selected a Fellow of the ASME in 2011. He arrived at NSF as an IPA rotator in May, 2014, and became a member of the permanent NSF staff in September 2018.

Dr. Irina Dolinskaya is a Program Director at the National Science Foundation (NSF) in the Division of Civil, Mechanical & Manufacturing Innovation (CMMI). Dr. Dolinskaya services Dynamics, Control and Systems Diagnostics (DCSD) program, as well as National Robotics Initiative (NRI 2.0) and Navigating the New Arctic (NNA) NSF's 10 Big Ideas. Prior to joining NSF, Irina Dolinskaya was a faculty in the Industrial Engineering and Management Sciences department at Northwestern University. She obtained M.S. and Ph.D. degrees in Industrial and Operations Engineering from the University of Michigan, and B.S. degree in Industrial Engineering from the University of Florida. Dr. Irina Dolinskaya's research is in the field of transportation science and logistics with focus on adaptive modeling and solution approaches to integrate dynamic real-time information. Her current primary applications are in humanitarian logistics, optimal vessel performance, and electric vehicle routing. Irina Dolinskaya is the winner of the INFORMS Transportation Science & Logistics Society Dissertation Prize and the 2008 recipient of the Bonder Scholarship for Applied Operations Research in Military Applications.

Dr. Robert G. Landers is a Curators' Distinguished Professor of Mechanical Engineering in the Department of Mechanical and Aerospace Engineering at the Missouri University of Science and Technology (formerly University of Missouri Rolla) and served as the department's Associate Chair for Graduate Affairs for eight years. He is currently a program manager at the National Science Foundation. He received his Ph.D. degree in Mechanical Engineering from the University of Michigan in 1997. His research interests are in the areas of modeling, analysis, monitoring, and control of manufacturing processes, and in the estimation and control of lithium ion batteries and hydrogen fuel cells. He has over 200 refereed technical publications and over $6M in research funding. He received the Society of Manufacturing Engineers' Outstanding Young Manufacturing Engineer Award in 2004 and the *ASME Journal of Manufacturing Science and Engineering* Best Paper Award in 2014. He is a Fellow of ASME, and a senior member of IEEE and SME.

Dr. Eduardo Misawa has a B.Sc. and M.Sc. degrees from University of Sao Paulo (1979 and 1983) and Ph.D. degree from the Massachusetts Institute of Technology (MIT, 1988), all in Mechanical Engineering with concentration in Dynamics and Control. He is currently a Program Director in the Directorate for Engineering at the National Science Foundation, where he manages the Engineering Research Centers (ERC) and Network for Computational Nanotechnology (NCN) programs. His research experience includes Nonlinear Dynamics, Nonlinear Control, Robust Control, Vibrations, Mechatronics, Nanotechnology, Precision Engineering, Vehicle Dynamics, Fluid Power Control, Bioinformatics, Biotechnology and Biomedical Engineering.

Women in Control Luncheon Meeting

Sponsor: **IEEE CSS Women in Control Committee**
Time: 12:00 – 1:30 Wednesday, July 1, 2020
Location: Ballroom F
Organizers: Dr. Linda Bushnell, University of Washington
Dr. Afef Fekih, University of Louisiana
Dr. Jacquelien M.A. Scherpen, University of Groningen

The IEEE CSS Women in Control committee is responsible for, but not limited to, promoting membership, gathering and disseminating appropriate information about women in IEEE CSS and the profession, and facilitating the development of mentoring and programs to promote the retention, recruitment, and growth of women IEEE CSS members. The IEEE WiC invites all ACC women attendees to join us for our traditional luncheon with interesting speakers on the first day of the conference, Wednesday, July 1st, 2020.

Research with Broad Scope and High Impact in an Industrial Laboratory

Sponsor: **Mitsubishi Electric (MERL)**
Time: 12:00 PM – 1:30 PM Wednesday, July 1, 2020
Location: Gold

Mitsubishi Electric Research Laboratories (MERL) is a leading research organization located in Cambridge,

Massachusetts, USA that conducts fundamental research for industrially-motivated problems. MERL is a subsidiary of Mitsubishi Electric Corporation, a $41B global manufacturer of a wide range of products including industrial robots, automotive electronics and equipment, HVAC (heating, ventilation, and air conditioning) systems, factory automation equipment, electrical power systems, elevators, satellites, and information visualization systems. MERL is an active and collaborative member of both the academic and industrial communities. MERL researchers collaborate with corporate laboratories and business units in Japan, as well as academic partners from around the world to develop novel solutions to challenging problems. In particular, several researchers at MERL develops new theoretical results in control and systems theory and apply them to a wide variety of products and applications.

In this talk we will present an overview of research activities at MERL, including fundamental controls research and the application of state-of-the-art control techniques to a variety of real-world systems. We will focus on fundamental research subjects including model predictive control and the control of constrained systems, estimation and motion planning for autonomous systems, and learning for control. In addition, we will describe how these fundamental research areas impact applications such as autonomous vehicles, spacecraft guidance and control, GNSS-based positioning, energy-efficient HVAC systems, high-precision manufacturing.

We encourage students, researchers and faculty interested in collaborating with MERL to attend this talk.

Speakers:

Dr. Karl Berntorp's research is on statistical signal processing, sensor fusion, and optimization-based control, with applications to automotive, aerospace, transportation, and communication systems. His work includes design and implementation of nonlinear filtering, constrained control, and motion-planning algorithms.

Dr. Claus Danielson's research interests are in model predictive control, constrained control, and networked control systems. His doctoral research was focused on exploiting symmetry in large-scale control and optimization problems.

Dr. Stefano Di Cairano's interests are model predictive control, constrained control, path planning, optimization algorithms, stochastic systems, and their applications to automotive, aerospace, and factory automation. Stefano is the Chair of IEEE CSS Technology Conferences Editorial Board, and the Vice-Chair of IFAC Technical Committee on Optimal Control.

Dr. Rien Quirynen's research interests are in model predictive control and moving horizon estimation, numerical algorithms for (nonlinear) dynamic optimization and real-time control applications. His doctoral research was focused on numerical simulation methods with efficient sensitivity propagation for real-time optimal control algorithms.

WEDNESDAY AFTERNOON SPECIAL SESSIONS

Women in Controls in Industry

Sponsor: **ASME Dynamic Systems and Control Division, Automotive and Transportation Systems Technical Committee and the Energy Systems Technical Committee**
Time: 1:30 PM – 3:30 PM, and 4:00 PM -6:00 PM, Wednesday, July 1, 2020
Location: Ballroom F
Organizers: Dr. Selina Pan, Toyota Research Institute
Dr. Marcello Canova, The Ohio State University
Dr. Mahdi Shahbakhti, University of Alberta
Dr. Yan Chen, Arizona State University
Dr. Carrie Hall, Illinois Institute of Technology

Academic research and industry development have a symbiotic relationship. The insights gleaned from academic research can be propagated into usable products and technologies by companies. The practical problems identified in industry can also inspire and develop new academic research topics and areas and these new areas of research and development can be explored jointly. This cycle and relationship is key for researchers to understand and to participate in. To facilitate these connections, every year, the ASME Dynamic Systems and Control Division organizes an industry special session at a major controls conference.

Nowadays, both academia and industry host increasingly diverse communities. These communities consist of researchers, engineers, teachers, programmers, and managers, and their members are thriving from many different backgrounds. A historically underrepresented group has been female engineers and engineers who identify as women. (For the purposes of brevity for this proposal, we will use the term "women" going forward.)

This session seeks to bring together both the importance of exposure to parallel work happening in industry, with the diverse people who are doing the work, to the American Control Conference. Academia is taking increasingly large strides to increase diversity in both its student population as well as its faculty. Industry is doing the same, in both similar and diverging ways, with efforts ranging from recruiting, changing hiring practices, evolving performance review processes, workshops in unconscious bias, employee resource groups, and setting diversity and inclusion as a company-wide initiative.

The speakers featured in this session have a variety of technical experiences and we aim to, first and

foremost, focus on their technical work and present a wide array of different career paths. The purpose of this is twofold: 1) to showcase some of the current cutting-edge work being done in industry in controls, and 2) to demonstrate examples and inspire junior women researchers who may be looking for a broader range of career paths. The session will feature both a series of technical talks, as well as a panel discussion that will be moderated and open to questions from the audience, in order to provide room to discuss potential non-technical topics unique to the experience of being a woman in controls in industry.

This special session is sponsored by the Automotive Transportation Systems and Energy Systems Technical Committee. The proposed list of speakers consists of engineers from the following companies: RightHook Robotics, Tesla, Applied Materials, Built Robotics, Waymo (Google), Ford, Toyota Research Institute, General Motors, and a stealth robotics startup.

Organization and Contribution

This session includes contributions from industry engineers who have been active in the areas of automotive, energy, and mechatronics research and development areas. The tentative list of speakers is compiled from the automotive, energy, robotics, and tech industries.

The session is roughly organized into two parts. The first part (1:30 – 4:50 PM) features technical talks from each speaker in their area of expertise. The speakers featured come from a variety of different companies. We propose to feature speakers from RightHook, Applied Materials, Waymo (Google), Tesla, Built Robotics, and Ford, with additional speakers pending company approval from Toyota, GM, and a stealth robotics startup. These companies are all leading the industry in the automotive, robotics, and controls areas.

The second part (4:50 PM – 5:30 PM) features a panel discussion with a subset of speakers, with Selina Pan (industry liaison from the Automotive Transportation Systems Technical Committee) as the moderator, welcoming questions from the audience. Being able to hear the speakers discuss their career and life experiences as women working in industry in controls has the potential to provide key insights and inspiration to aspiring junior engineers who are still seeking a career path in STEM, whether in research, academia, industry, or the start-up world. Because the session focuses on women in controls, we see great value in presenting the stories of established speakers behind their technical work.

Presentations:

Speaker: Dr. Madeline Goh, RightHook Robotics
Abstract: Highly Automated Driving Development and the Simulation Portability Problem - For the last several years, questions have swirled around how autonomous vehicles will be validated. The general consensus has come to a mix of on-road testing and simulation. With so many companies and stakeholders in the mix, how will standards be determined and met? We present ScenarioScript: an open, portable specification for describing scenarios used for developing, testing, and demonstrating automated vehicle systems.

Speaker: Dr. Caroline Le Floch, Tesla

Speaker: Dr. Raechel Tan, Applied Materials
Abstract: Advanced Control Applications in Semiconductor Processing Equipment - In semiconductor processing equipment, achieving the best device performance and yield requires minimal process variation.

Fast controls is also important, since this determines the rate at which wafers can be processed. At Applied Materials, the Common Solutions Group is working on advanced control solutions to enable greater precision and faster throughput.

Speaker: Dr. Sarah Thor, Built Robotics
Abstract: From Human Algorithms to Computer Algorithms: A High-Level Planning Problem - Built Robotics is building the future of construction by developing AI guidance systems to transform construction equipment into autonomous robots. The technology combines sensors, such as GPS, cameras and lidar with proprietary software, in order to make construction safer and more productive. Human operators already possess great skill in operating heavy construction machinery, such as bulldozers, excavators and skid steers. Before an operator begins moving dirt, he or she has an inherent algorithm in mind on how to take the current terrain and transform it to meet the job specifications. Our robots must also assess the current terrain and autonomously come up with a plan to accomplish the same job specifications. As robots have different capabilities to humans, the algorithm a human uses does not strictly overlap with the robot's algorithm. In this talk, we will go over some of the techniques and considerations human operators keep in mind for high-level planning of the job and discuss how Built Robotics tackles the high-level planning problem.

Speaker: Dr. Xin Zhou, Waymo (Google)
Abstract: This talk will focus on how individuals with training and expertise in control can branch into new technical disciplines, discover new research challenges at the interface of control and other fields, and explore different career options. Using my own experience, I will give several examples about how knowledge in control can help with many aspects of the development of driver-assist and autonomous driving technologies, including control and planning, object tracking, and deep learning. At the end of the talk, a brief introduction to Waymo will be given.

Speaker: Dr. Sara Dadras, Ford
Abstract: According to the National Highway Traffic Safety Administration (NHTSA), in 2017 alone, the NHTSA reported 34,247 fatal crashes in the United States with 37,133 fatalities. Furthermore, as of August 1, 2019, the California DMV has received 186 Autonomous Vehicle Collision Reports. Ford Motor Company aims to help society with not only providing the safest vehicles on the road but also making the vehicles more comfortable for the customers. Automated driving is one solution that significantly improves roadway safety. This talk gives an overview of Ford Greenfield Labs at Palo Alto, California, and reviews some areas of research in automated driving systems.

Panel Discussion
- **Dr. Madeline Goh**, RightHook Robotics
- **Dr. Raechel Tan**, Applied Materials
- **Dr. Sarah Thornton**, Built Robotics
- **Dr. Sara Dadras**, Ford

Speaker bios:
Dr. Madeline Goh left Minnesota and academia after earning her PhD in mathematics to pursue a career in industry. She is particularly inspired by solving problems that impact people's daily lives, from barcodes to self-driving vehicles. Currently she is a Machine Learning Expert and Senior Engineer at San Jose based startup, RightHook, Inc. RightHook provides a simulation platform for testing and development of

autonomous vehicles. Madeline is a people person and loves spending time with her siblings, urban exploration, puppies, and supporting women in technology.

Dr. Caroline Le Floch leads the development of the Autobidder software at Tesla, the first automated and algorithmic bidding platform for utility scale energy storage. I obtained a Master of Science in Applied Mathematics from Ecole Polytechnique (Paris, France), and PhD in Civil and Environmental Engineering at UC Berkeley. During my PhD in the Energy Controls and Applications Lab at UC Berkeley, I focused on Smart Charging optimization methods for large fleets of electric vehicles, including distributed optimization and Plug and Play model predictive Controls. After PhD I created a startup and sold smart charging software to automakers and aggregators. In May 2018 I joined the energy optimization team at Tesla, where I have focused on utility scale projects and the development of algorithmic bidding in energy markets. I am the leading engineer for Autobidder – the money making machine – that automates bidding of energy storage assets in electricity markets.

Dr. Raechel Tan is a controls engineering manager in the Mechatronics Center of Excellence at Applied Materials. She leads a team to develop advanced solutions for temperature, pressure, and motion control across the company. Before starting at Applied Materials, she obtained her Ph.D. in Mechanical Engineering at UC Berkeley, where she did research on automotive engine control.

Dr. Sarah Thornton received her Ph.D. in mechanical engineering at Stanford University in 2018. Her thesis was on designing autonomous vehicle motion planning algorithms with ethical considerations. She obtained her Master's in mechanical engineering from MIT in 2013 and her Bachelor's in mechanical engineering from UC Berkeley in 2011. She currently works as a Senior Robotics Engineer at Built Robotics, where she has worked on an array of projects ranging from designing parts of their safety system to designing high-level planning algorithms.

Dr. Xin Zhou received her PhD from the University of Michigan in Mechanical Engineering in 2017 with a focus on control, estimation, dynamic system modeling and identification. Prior to joining the University of Michigan, she received her Bachelor of Engineering in Machine Design, Manufacturing, and Automation from Huazhong University of Science and Technology, Wuhan, China, in 2012. Dr. Zhou joined Aptiv immediately after receiving her doctorate to develop object tracking algorithms for advanced driver-assistance systems. In 2018, she joined Waymo as a Software Engineer/Robotics Researcher focusing on perception of the autonomous vehicle. She is the lead author of six publications and a finalist for three best student paper awards and a best paper award.

Dr. Sara Dadras (IEEE Senior Member, 2018) is currently an Automated Driving Senior Research Engineer at Ford Motor Company. Prior to that, she was a research engineer working on research and development of Plug-in Hybrid Electric Vehicle systems with respect to energy management. Passionate about vehicles, she worked on various projects including battery management systems, wireless power transfer systems, model based system design for advanced HEVs and PHEVs. Her current research interest areas include autonomous vehicles, advanced driver assist systems, hybrid electric and electric vehicles, nonlinear systems and control, and application of fractional calculus in control of nonlinear systems. Dr. Dadras was the recipient of the 2019 Forest R. McFarland Award (SAE) and Ford 2018 R&A Technical Achievement Award (RARE Award). She is the Associate Editor of the IEEE Transactions on Control Systems Technology, IEEE Access, IEEE Transactions on Automation Science and Engineering, Asian Journal of Control and Conference Editorial Board member of IEEE.

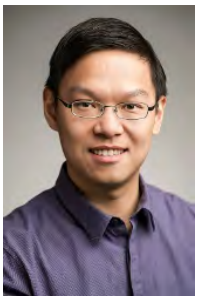
NREL's Control Research: Enabling a Clean Energy Future

Sponsor: **The Department of Energy National Renewable Energy Laboratory**
Time: 1:30 PM –3:00 PM Wednesday, July 1, 2020
Location: Gold

The National Renewable Energy Laboratory (NREL), located in Golden, Colorado, is the United States' primary laboratory for renewable energy and energy efficiency research and development. Control plays a crucial role in NREL's mission to advance the science and engineering of energy efficiency, sustainable transportation, renewable power technologies, and energy systems integration. This special session will provide an overview of NREL, followed by in-depth discussion of NREL's control research in various areas such as building, grid, wind, energy storage, and transportation. The goal of the session is to give the audience an opportunity to understand the typical control research projects at NREL and how to collaborate with NREL.

Presentations:

1. **Dr. Xin Jin, "**Model Predictive Control for Grid-Interactive Efficient Buildings and Communities"
2. **Dr. Andrey Bernstein, "**Learning to Optimally Control Grid-Interactive Efficient Buildings"
3. **Dr. Jennifer King and Dr. Christopher Bay, "**Autonomous Wind Farms: Distributed Optimization and Control for Wind"
4. **Dr. Ying Shi, "**Advanced Controls of Energy Storage Systems for Better Performance, Safety, and Life"
5. **Dr. Myungsoo Jun, "**Smart Electric Vehicle Charge Management for Demand Charge Mitigation"



Dr. Xin Jin is a Senior Research Engineer in the Buildings and Thermal Sciences Center at NREL. He is also the Sensors and Controls innovation area lead of NREL's Buildings program. His research focuses on building-to-grid integration, building control, machine learning with applications in buildings, and fault detection and diagnosis. Dr. Jin leads several research projects funded by the U.S. Department of Energy Building Technologies Office and Solar Energy Technologies Office. He is the lead developer of foreseeTM, a user-centric, cybersecure home energy management system. He received his Ph.D. in Mechanical Engineering from Pennsylvania State University. He has authored more than 50 peer reviewed technical publications and 10 software records and U.S. patent. He is an ASHRAE member and IEEE member, and is a recipient of the 2018 R&D 100 Award and 2017 NREL President Award.

Dr. Andrey Bernstein received his B.Sc., M.Sc. (both summa cum laude), and Ph.D. degrees in Electrical Engineering from the Technion - Israel Institute of Technology. Between 2010 and 2011, he was a visiting researcher at Columbia University. During 2011-2012, he was a visiting Assistant Professor at the Stony Brook University. From 2013 to 2016, he was a postdoctoral researcher at the Laboratory for Communications and Applications of Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland. Since October 2016 he has been a Senior Scientist at NREL. In February 2018, he became a group manager for the Energy Systems Control and Optimization Group. His research interests are in the decision and

control problems in complex environments and related optimization and machine learning methods, with particular application to power and energy systems.

Dr. Jennifer King is a Research Engineer at NREL working at the National Wind Technology Center on hybrid system modeling and control. This includes developing model and real-time distributed optimization capabilities for wind farm control, optimally designing and operating utility-scale hybrid power plants as well as developing a control framework for large-scale autonomous energy systems. Jennifer obtained her Ph.D. in Aerospace Engineering and Mechanics from the University of Minnesota in 2016 where her primary focus was on reduced-order modeling for wind farm control. Her current research focus areas are in reduced-order modeling, distributed control/optimization, and flow control.

Dr. Christopher Bay is a Research Engineer at NREL. His current work includes wind farm control and optimization, involving distributed control and layout design to improve performance and meet secondary objectives. He is also tackling multi-system problems through developing cooperative control between wind energy plants and buildings. Christopher received his Ph.D. in Mechanical Engineering from Texas A&M University in 2017 where his research centered around scalable, distributed control of building energy systems.

Dr. Ying Shi is a Senior Research Engineer in Power Systems Engineering Center at NREL. She has been working on lithium-ion battery systems testing, modeling, analysis and control to improve battery performance and life, increase pack utilization and reduce upfront and lifetime cost for stationary and automotive applications. Dr. Shi received a bachelor's degree in Mechanical Engineering from Shanghai Jiao Tong University in Shanghai, China in July 2008. She received dual master's degree in electrical engineering and mechanical engineering from Pennsylvania State University in University Park, PA, USA, in May 2012 and May 2013. She received her Ph.D. degree in mechanical engineering from Pennsylvania State University in December 2013, with focus on modeling, real-time identification and remediation of degradations in lead-acid batteries for hybrid locomotive applications

Dr. Myungsoo Jun has been performing research on vehicle electrification, EV charging station management, and smart transportation systems. He is currently actively conducting research on smart charge management and battery BMS for EV. He also led a project on smart intersection sensing systems. Before joining NREL in 2011, Dr. Jun had extensive experiences in the areas of autonomous ground vehicles and unmanned aerial vehicles including UAV/UGV trajectory planning, dynamic collision avoidance, and attitude estimation with vision camera sensors. He conducted projects on UAV/UGV funded by DARPA, AFRL, and JPL during his affiliation with Oshkosh Corp., University of Florida, and Cornell University.

THURSDAY NOON SPECIAL SESSIONS

Control Design for SuperCruise Automated Driving: Systems, Algorithms, Challenges and Solutions

Sponsor: **General Motors**
Time: 12:00 – 1:30 PM Thursday, July 2, 2020
Location: Room 51

Automated vehicles are computers that perform several functions necessary to understand the world and make driving decisions. Developing such systems is challenging, since driving is a multi-variable, multi-objective, nonlinear and sometimes uncertain task, in which multiple agents including drivers, pedestrians, devices and environment interact in real-time.

This talk provides a technical review of lateral controls in GM's SuperCruise, the industry's first hands-free driving technology for the highway. Several aspects of the system are discussed, including systems and components, hardware redundancy to ensure safety, hardware/software integration, and technical aspects in vehicle dynamics, sensing, fusion, path planning and controls.

Specific case studies are provided which highlight application of controls techniques to develop various functionalities that enable operation of SuperCruise.

Dr. Reza Zarringhalam is Global Technical Lead for Lateral Controls at General Motors Canada Technical Center. He is currently leading the design of advanced lateral controls software at GM for various features including SuperCruise. Before joining GM Canada, Reza had more than 10 years of R&D experience in controls and automotive industry, including his MSc research on applications of AI for automated driving at K.N.T.U, Iran; and his PhD research on fault-tolerant estimation of vehicle states at University of Waterloo, Canada. Reza has made numerous contributions through patents and publications, is a reviewer of multiple international journals and has extensive teaching experience in Controls and Mechatronics. He is passionate about technology and innovation to build a better future, today.

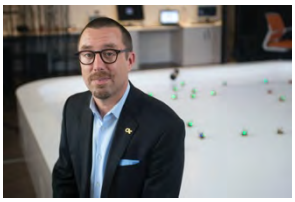
Bridging the Theory-Practice Gap in Robotics on a Massive Scale in Georgia Tech's Robotarium

Sponsor: **Mathworks**
Time: 12:00 PM – 1:30 PM, Thursday, July 2, 2020
Location: Room 50

The Robotarium is a remotely accessible swarm robotics lab that allows users from all over the world to upload control code, written in MATLAB, and run experiments. Since its official launch in August 2017, over 5000 remote experiments have been conducted by users from all continents (except Antarctica). The impetus behind the Robotarium project is to provide broad, democratized access to a world-class research facility, and users span the gambit from robotics researchers to middle-school students. This talk will discuss the technical challenges associated with the Robotarium as well as a lessons learned in remote-

access experimentation.

Dr. Magnus Egerstedt, Steve W. Chaddick School Chair and Professor in the School of Electrical and Computer Engineering at the Georgia Institute of Technology.



THURSDAY AFTERNOON SPECIAL SESSIONS

Promoting Access for Under-represented Groups in STEM Graduate Disciplines

Time: 1:30 PM – 3:30 PM, Thursday, July 2, 2020
Location: Silver

This session consists of four presentations that addresses successful academic and professional practices that support completion of a STEM graduate education and transition to the professoriate for under-represented groups.

A motivation for the session is that the demographics in the U.S. is changing but noticeably, the number of graduate degrees in STEM disciplines remain unpopulated by this change. To meet this rising change, professional societies and academic institutions must embrace systematic and thoughtful changes in how access is provided, how practices are implemented, and what policies are crafted.

This session is intended to serve three purposes: (i) present the challenges faced by under-represented groups at the graduate level, (ii) provide examples of programs and/or procedures that bolster graduate education in STEM disciplines, and (iii) have an open dialogue about the difficulties of instituting systemic change at the professional society, academic institution, college, and department levels.

Outline of the session:

1. **Dr. Karlene Hoo** (Gonzaga University), "Brief Opening Remarks to Introduce the Topic"
2. **Dr. Bozenna Pasik-Duncan** (University of Kansas), "STEM Education of Tomorrow"
   A collaborative effort integrating scholarship, teaching, learning and broader impacts is the key to a success in STEM education. This collaborative effort needs to include academia, industry, government as well as teachers, parents, students and scholars. By working together as partners who are all learners in the process of STEM education, we can make a difference. Best practices in this effort are shared.
3. **Dr. Martha Grover** (Georgia Institute of Technology), "Graduate Training for Equality in Under-represented Academic Leadership"
   The need to fund students on research grants may provide an unnecessary barrier to retention of PhD students from non-traditional backgrounds. Here we discuss the details of a program in the

School of Chemical & Biomolecular Engineering at Georgia Tech, funded by ACS-Bridge, to expand the number of students from under-represented groups earning a PhD in the chemical sciences. The MS thesis program is utilized as a bridge from the BS to the PhD through modifications in timeline and sequencing, as well as additional mentoring.

4. **Dr. Karlene Hoo** (Gonzaga University), "Pathways to Support STEM Graduate Education for Indigenous Communities"
   The NSF AGEP (Alliance for Graduate Education and the Professoriate) PNW COSMOS (Pacific NorthWest Collaborative Opportunities for Success in Mentoring of Students) Alliance's project was to address the scarcity of American Indian/Alaska Native (AI/AN) graduate students in STEM programs. In this presentation, two mentoring frameworks to promote retention and support of AI/AN graduate students will be described. The NSF-funded project resulted in the publication "Indigenous Communities and Access to Graduate Degrees in STEM," 2019 (eds: Hoo & Windchief) New Directions for Higher Education, No. 187.

5. **Dr. Bonnie Ferri** (Georgia Institute of Technology) and Leslie Sharp (Georgia Institute of Technology), "Hiring and Supporting a Diverse Faculty"
   This interactive session will explore some of the issues, challenges, and opportunities for hiring and supporting a diverse faculty in STEM disciplines. What are factors that influence the decision of under-represented groups to apply for and consider faculty positions? What are some policies, practices, and programs that support a healthy and productive culture among a diverse population? Do our promotion and advancement practices need retuning? What contributions can a professional society have to support success? Finally, what can each of us do individually to support diversity, equity, and inclusion in the faculty ranks?

   Note: Bonnie Ferri will conduct the session. Leslie Sharp (Associate Vice Provost for Graduate Education and Faculty Development, and CEO of the Library) will help to prepare the presentation materials and activities but will not be present at the session.

Dr. Bozenna Pasik-Duncan received M.S. degree in mathematics from University of Warsaw (Poland), and Ph.D. and D.Sc. (Habilitation Doctorate) degrees from Warsaw School of Economics (Poland). She is Professor of Mathematics; Courtesy Professor of EECS & AE; Investigator at ITTC; Affiliate Faculty at Center of Computational Biology, and Chancellors Club Teaching Professor at University of Kansas (Lawrence, KS). She is 2017-2018 IEEE Women in Engineering (WIE) Global Chair, founder of IEEE CSS Women in Control, founder and faculty advisor of Student Chapters of Association for Women in Mathematics (AWM) and Society for Industrial and Applied Mathematics (SIAM) at KU, founder and coordinator of KU and IEEE CSS Outreach Programs, a Life Fellow of IEEE, and Fellow of IFAC. She is recipient of many awards that include IREX Fellow, NSF Career Advancement Award, Louise Hay Award, Polish Ministry of Higher Education Award, H.O.P.E. Award, Kemper Fellowship, IEEE Educational Activities Board Meritorious Achievement Award, the IEEE Third Millennium Medal and IEEE Control Systems Society Distinguished Member Award. She is inducted to the KU Women's Hall of Fame. Her broad research interests are primarily in stochastic adaptive control and its applications to science and engineering, and in STEM education.

Dr. Karlene Hoo received her a B.S. degree from the University of Pennsylvania (Philadelphia, PA) and her M.S. and Ph.D. degrees from the University of Notre Dame (Notre Dame, IN). All her degrees are in chemical engineering. She is currently, Dean of the School of Engineering & Applied Science at Gonzaga University (Spokane, WA). She held prior academic administrative positions at Texas Tech University (Lubbock, TX) and at Montana State University (Bozeman, MT). She has government experience with the National Science Foundation (Engineering Directorate), NASA Johnson Space Center, and Sandia National Laboratories. She also has industrial experience with Exxon and DuPont. In 2009, she served as the General Chair of the American Control Conference (St Louis, MO). Her research interests are in sustainable chemical process designs, cardiovascular research, biofuel technologies, and graduate STEM education.

Dr. Bonnie Ferri received her a B.S. degree in electrical engineering from the University of Notre Dame (Notre Dame, IN), her M.S. degree in mechanical and aerospace engineering from Princeton (Princeton, NJ), and her Ph.D. degree in electrical engineering from Georgia Institute of Technology (Atlanta, GA). She is currently the vice provost for Graduate Education and Faculty Development at Georgia Institute of Technology. Her research interests are in embedded control systems, engineering education, and real-time computing. She has received many honors and awards including the 2017 IEEE Undergraduate Teaching Award and the 2016 Regent's Award for the Scholarship of Teaching and Learning. She was the co-chair of a campus-wide commission at Georgia Tech on the future of higher education, an invited speaker at a National Academy of Engineering workshop on education, and a keynote speaker at the 2019 IFAC Advances in Control Education Symposium. She is the General Chair of the 2022 American Control Conference to be held In Atlanta, GA.

Dr. Martha Grover received her a B.S. degree from the University of Illinois (Champaign, IL) and her M.S. and Ph.D. degrees from the California Institute of Technology (Pasadena, CA). She is Professor and Associate Chair for Graduate Studies in Chemical & Biomolecular Engineering at Georgia Tech and co-leads the new Graduate Training for Equality in Underrepresented Academic Leadership Program funded by the American Chemical Society through the NSF INCLUDES Network. Her research interests are in control of molecular organization, with applications in feedback control of colloidal crystallization for photonic materials, chemical evolution in the origins of life, modeling and control of pharmaceutical and nuclear waste crystallization, and process-structure-property relationships in polymer organic electronics. Martha is the Program Chair of the 2020 American Control Conference and the General Chair for ACC in 2024. She also is the incoming chair for the AIChE Computing and Systems Technology Division and the IEEE CSS Liaison to the IEEE Women in Engineering (WIE) Committee.

Getting Funded by NSF: Proposal Preparation and the Merit Review Process

Sponsor: **National Science Foundation**
Time: 4:00 PM – 6:00 PM, Thursday, July 2, 2020

Location: Denver

So, you think you have a great research idea, now how do you get funding from the National Science Foundation (NSF) to do the work? A well-scoped and written proposal is instrumental to successful submission. This session targets junior faculty and researchers who might be new to NSF and describes detailed guidelines and practical advice for proposal preparation. The presenter will go over NSF review process and Intellectual Merit and Broader Impacts criteria, as well as share most common mistakes made by the Primary Investigators when submitting a proposal. Question-and-answer session will follow the presentation.

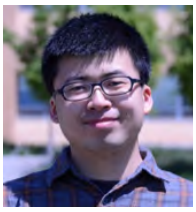
Dr. Irina Dolinskaya is a Program Director at the National Science Foundation (NSF) in the Division of Civil, Mechanical & Manufacturing Innovation (CMMI). Dr. Dolinskaya services Dynamics, Control and Systems Diagnostics (DCSD) program, as well as National Robotics Initiative (NRI 2.0) and Navigating the New Arctic (NNA) NSF's 10 Big Ideas. Prior to joining NSF, Irina Dolinskaya was a faculty in the Industrial Engineering and Management Sciences department at Northwestern University. She obtained M.S. and Ph.D. degrees in Industrial and Operations Engineering from the University of Michigan, and B.S. degree in Industrial Engineering from the University of Florida.

Dr. Dolinskaya's research is in the field of transportation science and logistics with focus on adaptive modeling and solution approaches to integrate dynamic real-time information. Her current primary applications are in humanitarian logistics, optimal vessel performance, and electric vehicle routing. Irina Dolinskaya is the winner of the INFORMS Transportation Science & Logistics Society Dissertation Prize and the 2008 recipient of the Bonder Scholarship for Applied Operations Research in Military Applications.

Student Career Advising Session

Time: 4:00 PM – 5:30 PM, Thursday, July 2, 2020
Location: Gold
Organizers: Ning Tian, Ting Cai, Dr. Alireza Goshtasbi

The session will be rotating roundtable discussions. The discussion panel features a diverse group of accomplished professionals from academia, national labs and industry. They will share insights and provide advice based on their successful careers in their respective fields. Students are encouraged to come with specific questions or simply listen in. Join us for an opportunity to network and learn more about shaping your career. Light refreshments will be provided.



Ning Tian is a Ph.D. candidate working with Dr. Huazhen Fang at the University of Kansas, Lawrence, KS. His research interests include control theory and its application to advanced battery management. He is currently a Student Liaison of the ASME DSCD Energy Systems Technical Committee. He received the B.Eng. and M.Sc. degrees in Thermal Engineering from Northwestern Polytechnic University, Xi'an, China, in 2012 and 2015, respectively.

Ting Cai is a Ph.D. candidate working with Dr. Jason Siegel and Dr. Anna Stefanopoulou at the University of Michigan. His research focuses on Li-ion battery control and safety, specifically the modeling and detection of battery faults. He is a recipient of the Energy Systems Technical Committee Best Paper Award in the 2018 ASME Dynamic Systems and Control Conference. He currently serves as a student liaison of the ASME DSCD Energy Systems Technical Committee. Ting received his B.S. in Mechanical Engineering from Xi'an Jiaotong University in 2016.

Dr. Alireza Goshtasbi is a Research Engineer at Ford Motor Company. His research interests include modeling, estimation, and control of electrochemical energy systems with special focus on fuel cells. Alireza served as a Student Liaison for the ASME DSCD Energy Systems Technical Committee from 2017 to 2019. He completed his PhD in Mechanical Engineering at the University of Michigan in 2019, where he also obtained his MS in Applied Mathematics and MS in Mechanical Engineering in 2019 and 2016, respectively.

Panelists:

Dr. Jason B. Siegel received his Bachelors of Electrical Engineering Summa Cum Laude from the University of Michigan in 2004 and Electrical Engineering Systems Ph.D. in 2010. After a two year post-doc, he joined the faculty as an Assistant Research Scientist in the Department of Mechanical Engineering at the University of Michigan in 2012. His research focuses on physics based modeling and control of energy storage and conversion systems including lithium-ion batteries and Proton Exchange Membrane fuel cells. Dr. Siegel was part of the team that received the 2016 IEEE Control Systems Technology Award, "for the development of an advanced battery management system accounting for electro-thermo-mechanical phenomena." He has co/authored more than 30 journal articles with an h-index of 16, and a chapter in the control systems handbook on the application of model predictive control to fuel cells. Dr. Siegel serves as the chair of the IEEE Technical Committee on Automotive Control.

Dr. Hamid Ossareh obtained his BASc in Electrical and Computer Engineering from the University of Toronto in 2008, and MASc (EE), MS (Mathematics), and PhD (EE) degrees from the University of Michigan, Ann Arbor in 2010, 2012, and 2013, respectively. He was a researcher at Ford Research and Advanced Engineering from 2013 to 2016, where he investigated advanced control of automotive powertrains. Since 2016, he has been an Assistant Professor in the Department of Electrical Engineering at the University of Vermont (UVM). His research interests lie in the area of control and, more specifically, constrained control, stochastic control, and nonlinear control with applications in automotive, aerospace, and power systems. He holds more than 35 patents and has been an author on more than 32 peer-reviewed publications, and has been a recipient of numerous awards, including the Chief Engineer's award and the Ford Technical Achievement award from Ford Motor Company, and the Faculty of the Year and Inventor of the Year awards from the IEEE GMS. He is the founding chair of the IEEE Control Systems Society Chapter of Vermont, an Associate Editor for the journal of Control Engineering Practice, and a member on the Conference Editorial Board of the IEEE CSS.

Dr. Helen Durand is an Assistant Professor in the Department of Chemical Engineering and Materials Science at Wayne State University. She received her B.S. in Chemical Engineering from UCLA, and upon graduation joined the Materials & Processes Engineering Department as an engineer at Aerojet Rocketdyne for two and a half years. She earned her M.S. in Chemical Engineering from UCLA in 2014 and her Ph.D. in Chemical Engineering from UCLA in 2017, and subsequently started at Wayne State. She received the Air Force Office of Scientific Research Young Investigator award, and her work has also received support from the National Science Foundation. She received a Faculty Research Excellence Award within the College of Engineering at Wayne State University and is serving as the Next-Gen Manufacturing Sessions Area Chair for the 2020 Annual Meeting of the American Institute of Chemical Engineers. Her research interests are in the area of process systems engineering with a focus on process control.

Dr. Neera Jain is the Principal Investigator of the Jain Research Laboratory. She joined the School of Mechanical Engineering and Ray W. Herrick Laboratories at Purdue University as an assistant professor in January 2015. She has authored more than a dozen peer-reviewed articles on the topics of dynamic modeling and control of thermal energy systems. From May 2013 through May 2014, Dr. Jain was a visiting member of the research staff in the Mechatronics Group at Mitsubishi Electric Research Laboratories in Cambridge, MA where she designed advanced control algorithms for HVAC systems. Before earning her doctorate in Mechanical Engineering at the University of Illinois at Urbana-Champaign in 2013, she earned her S.B. from the Massachusetts Institute of Technology in 2006 and her M.S. from the University of Illinois at Urbana-Champaign in 2009, both in Mechanical Engineering. Dr. Jain is a recipient of the Department of Energy Office of Science Graduate Fellowship (2010-2013) and the ASME Graduate Teaching Fellowship (2011-2012).

Dr. Masoud Abbaszadeh received the B.Sc. degree from the Amirkabir University of Technology, Tehran, Iran, in 2000, the M.Sc. degree from the Sharif University of Technology, Tehran, Iran, in 2002, and the Ph.D. degree from the University of Alberta, Edmonton, AB, Canada, in 2008, all in electrical and computer engineering. He is currently a Senior Research Engineer at GE Research, Niskayuna, NY, USA and an Adjunct Professor at the ECSE Department, Rensselaer Polytechnic Institute, Troy, NY, USA. From 2011 to 2013, he was a Senior Research Engineer at the United Technologies Research Center, East Hartford, CT, USA. From 2008 to 2011, he was with Maplesoft, Waterloo, ON, Canada. He was the Principal Developer of MapleSim Control Design Toolbox and was a member of a research team working on Maplesoft-Toyota joint projects. Dr. Abbaszadeh is an Associate Editor of IEEE Transactions on Control Systems Technology and a member of IEEE Control Systems Society Conference Editorial Board. His current research interests include estimation and detection, robust and nonlinear filtering, and statistical machine learning with applications such as cyber-physical resilience and autonomous systems. He has published over 80 peer-reviewed papers and has over 40 issued/pending patents.

Mr. Rajiv Singh holds degrees in Aerospace (1998) and Mechanical (2000) Engineering and is currently a PhD candidate in Electrical Engineering at Northeastern University. His current research is focused on convex methods for nonlinear system identification. Since 2000, he has been with MathWorks where he leads the development of data based modeling software. He has been the lead developer of the System Identification Toolbox since 2010. He has also led the development effort behind launching the Predictive Maintenance Toolbox in 2018. Rajiv has authored numerous papers in the area of system identification and statistical modeling and hold 3 patents in related areas.

Dr. Leo H. Chiang is Technology Director at Dow Inc., leading Chemometrics and AI implementations for Manufacturing. Leo has developed and implemented several data analytics techniques to solve complex manufacturing problems, resulting in 11 Dow Manufacturing Technology Center Awards. In 2016 he received the Dow R&D Excellence in Science Award in recognition of his scientific achievement in industrial research. Leo has a B.S. degree from University of Wisconsin at Madison and M.S. and Ph.D. degrees from the University of Illinois at Urbana-Champaign, all in Chemical Engineering. Leo has contributed to over 40 externally refereed journal/proceedings papers and has given over 100 conference presentations and university lectures. Leo has co-authored two books published by Springer Verlag. His textbook Fault Detection and Diagnosis in Industrial Systems is available in English and Chinese and has received over 2,200 citations according to Google Scholar.

Leo has a long history of supporting American Institute of Chemical Engineers (AIChE), having served as 2014-2016 Computing and Systems Technology (CAST) director, 2016 CAST 10E programming chair, 2017-2018 spring meeting program chair (MPC), and recently elected to serve the 2019-2022 Executive Board of the Program Committee (EBPC). Leo was instrumental in setting up the Big Data Analytics Topical Conference (2015 to 2017) and Industry 4.0 Topical Conference (2018-2020) at the AIChE spring meeting. He was recognized by the AIChE with the 2016 Herbert Epstein Award for his leadership on Big Data Analytics technical programming and 2016 Computing Practice Award for his world-class leadership in the development and application of methodologies in analytics for batch and continuous processes known as Big Data. Leo is also active in the broader engineering and control community, currently serves as 2019-2021 Computer Aids for Chemical Engineering (CACHE) trustee, 2021 International Symposium on Advanced Control of Chemical Processes (ADCHEM) industry co-chair, and 2022 American Control Conference (ACC) vice chair for industrial applications.

Dr. Jennifer King (Annoni) received her PhD in Aerospace Engineering and Mechanics from the University of Minnesota in 2016. She is currently a research engineer at the National Renewable Energy Lab (NREL) at the National Wind Technology Center. Her research spans from engineering to policy. Her expertise includes control systems, flow control, system identification, and reduced-order modeling with application to wind farm control, with specific work done on mode decomposition, optimal estimation and control, robust control, and energy policy.

Dr. Alexander Scheinker received a MA in mathematics in 2008 and a PhD in nonlinear adaptive control theory in 2012 at the University of California, San Diego. Alex spent the last two years of his PhD as a Graduate Researcher at Los Alamos National Laboratory (LANL) and was hired as a staff member with the RF Control Group in 2011 where he continues theoretical and applied control theory research. While traditional Extremum Seeking (ES) approaches were for the optimization of the unknown outputs of known stable/controlled systems, Alex developed a new bounded form of ES for use as a direct feedback for the stabilization, optimization and control of unknown and unstable time-varying nonlinear systems. Alex has combined the ES feedback control method with machine learning (ML) techniques for adaptive ML of time varying systems. Alex has demonstrated this method in hardware for various particle accelerator applications: electron beam orbit control at the SLAC National Accelerator Laboratory SPEAR3 and the Brookhaven National Laboratory NSLS-II particle accelerator light sources, beam loss minimization at the LANL LANSCE proton linear accelerator, automatic longitudinal phase space control and average pulse energy output maximization at the SLAC National Accelerator Laboratory Linac Coherent Light Source and the European X-ray free electron laser, trajectory and emittance control at CERN's plasma wakefield acceleration project AWAKE, and non-invasive longitudinal phase space diagnostics at the FACET plasma wakefield accelerator at SLAC national accelerator laboratory.

Dr. David Schoenwald is a Principal Member of the Technical Staff in the Electric Power Systems Research Department at Sandia National Laboratories. Dr. Schoenwald focuses on control system design to improve dynamic stability of electric power systems. He also develops performance standards for grid-scale energy storage applications. Before joining Sandia, he was with Oak Ridge National Laboratory, where he designed control systems for manufacturing applications. He was also an adjunct assistant professor in the Electrical Engineering Department, University of Tennessee, Knoxville, where he taught a graduate course on nonlinear control systems. Dr. Schoenwald received an R&D 100 award in 2017 for development of an inter-area oscillation damping controller for the western North American power grid. He received the 2017 Outstanding Engineer Award of the Albuquerque Section of the IEEE. He served as Technical Co-Chair of the 2017 Electrical Energy Storage Applications & Technologies (EESAT) Conference. Dr. Schoenwald received his Ph.D. degree in electrical engineering from The Ohio State University.

TUTORIAL SESSIONS

Tutorial sessions showcase specific control topics that address real world control applications and how effective solutions are engineered by practicing engineers. This year we are pleased to offer four tutorial sessions.

WeB21 Cooperation in Pursuit-evasion Differential Games

Organizer: Eloy Garcia, Chair of IEEE Technical Committee on Manufacturing Automation and Robotic Control (MARC), Control Science Center of Excellence, Air Force Research Laboratory, Wright-Patterson AFB

Co-organizers: Isaac E. Weintraub, Aerospace Systems Directorate, Air Force Research Laboratory, Wright-Patterson AFB
Meir Pachter, Department of Electrical Engineering, Air Force Institute of Technology, Wright-Patterson AFB

Time: 13:30 – 15:30, Wednesday, July 1, 2020

Location: **Director's Row H**

This session will introduce the basics of pursuit-evasion problems. Pursuit-evasion problems provide a general framework that mathematically formalizes important applications in different areas such as surveillance, navigation, analysis of biological behaviors, and conflict and combat operations. Pursuit-evasion sets up two players or autonomous agents against each other; generalizations are typical in the sense of multiple players divided into two teams – the pursuer team against the evader team.

Strategy seeking in pursuit-evasion has been approached by imposing certain assumptions on the behavior of one player or team. However, many pursuit-evasion scenarios must address the presence of an intelligent adversary which does not abide by a restricted set of actions. The desire to design strategies that optimize a certain criteria against the worst possible actions of the opponent and that also provide robustness with respect to all possible behaviors implementable by the adversary led to the emergence of differential game theory. The central problem in pursuit evasion differential games is the synthesis of saddle-point strategies that provide guaranteed performance for each team regardless of the actual strategies implemented by the adversary. This is a challenging problem as it generalizes optimal control to simultaneously minimize and maximize a performance functional while satisfying implicit robustness requirements. Many questions and open problems remain in this area where the controls community has the potential for important breakthroughs and take differential games a leap forward both in theoretical and practical terms.

Presenters: Isaac E. Weintraub, Meir Pachter, and Eloy Garcia: **An introduction to pursuit-evasion differential games**
Shaunak D. Bopardikar: **k-Capture in Multi-agent Pursuit Evasion, or the Lion and the Hyenas**
Meir Pachter: **Multi-Player Pursuit-Evasion Differential Games**
Zachariah Fuchs: **Singular Surfaces within a Two Evader, One Pursuer Game**

ThB21 Control of Tokamak Fusion Plasmas

Organizers: Michael L. Walker, General Atomics

Co-organizers: Federico Felici, EPFL
Eugenio Schuster, Lehigh University
Peter De Vries, ITER

Time: 13:30 – 15:30, Thursday, July 2, 2020

Location: **Director's Row H**

Significant progress has been made in the last several decades since controlled magnetic fusion was envisioned as a potential commercial power source. The effort initially focused on achieving the necessary scientific understanding of fusion plasmas, and how best to produce energy generating fusion reactions within those plasmas. But as greater scientific understanding was gained, more attention gradually began to be paid to the technological issues associated with confining and controlling the plasmas creating these energy-producing reactions. Initial active control approaches consisted primarily of a small number of SISO PID controllers. More recently, as the number of plasma parameters desired to be controlled has increased, more sophisticated controllers have been designed, implemented, and tested on a number of experimental fusion devices worldwide.

Up to now, magnetic-fusion research devices have not been capable of hosting a plasma with the frequency of fusion reactions sufficient to produce more output power than is consumed in confining and controlling the plasma, a basic requirement for an energy-producing fusion reactor. This situation is about to change with the anticipated completion of the ITER tokamak currently under construction in southern France. ITER is projected to be able to produce approximately 10 times more energy output than it consumes when it is fully operational in approximately 20 years. Early operation of ITER will focus on learning how to produce and control plasmas that are far more energetic than in any existing magnetic-confinement device. The initial plasma control system is being designed now, including both the software architecture and the algorithms that will be used for control during ITER "first plasma" operation in approximately 2025. Energy content of plasmas produced during this phase of operation are small when compared with plasmas planned for later operation phases, which means that consequences of most possible control failures are similarly small. However, even during this early phase there are certain control failures that can lead to millions of dollars in device damage, so getting the control right is an important task.

Presenters: Michael Walker, **Introduction to Tokamak Plasma Control**
Federico Felici, **Control of magnetic fields and instabilities in tokamak fusion plasmas**
Eugenio Schuster, **Core Kinetic and Magnetic Control in Tokamak Plasmas**
Peter De Vries, **Exception handling by the Plasma Control Systems of Tokamaks**

ThC21 Control of Wafer Scanner: Methods and Developments

Chair: Marcel Heertjes, Eindhoven University of Technology

Organizer: Marcel Heertjes, Eindhoven University of Technology

Co-organizers: Hans Butler, ASML
Stan van der Meulen, ASML
Rahul Ahlawat, CYMER

Time: 16:00 – 18:00, Thursday, July 2, 2020

Location: **Director's Row H**

This tutorial session addresses control design aspects for wafer scanners, used in the semiconductor manufacturing industry, and the challenges for control design and development to meet the ever increasing demands on accuracy and speed. The mechatronic systems that will be discussed are: (a) the light source needed to generate the ultraviolet light that is used for wafer exposure, (b) the optical and metrology systems needed for accurate measurement and imaging, and (c) the reticle and wafer stage systems needed for accurate and fast positioning. The control challenges associated with these systems mainly involve dealing with: (a) rejection of high frequency aliased disturbances, (b) large-scale or fast-updated (state) reconstruction, (c) vibration control and isolation in view of structural vibrations and disturbances, (d) inherent design tradeoffs like Bode's sensitivity integral and gain-phase relationship, (e) multivariable plant identification of (quasi-static) deformations and structural dynamics for point-of-interest control, and (f) thermal modelling, model reduction, and the control of (local) time-varying deformation.

Presenters: Marcel Heertjes: **General introduction wafer scanners**
Rahul Ahlawat: **Light source: generation and control of light**
Hans Butler: **Optics: Isolation and control of vibration**
Marcel Heertjes: **Stages pt.1: control of motion**
Stan van der Meulen: **Stages pt.2: control of thermal-induced deformation**

FrB21 Learning and Control: Opportunities and Challenges

Chair: Mathukumalli Vidyasagar, Indian Institute of Technology, Hyderabad

Organizer: Mathukumalli Vidyasagar

Co-organizer: Behrouz Touri, University of California San Diego

Time: 13:30 – 15:30, Friday, July 3, 2020

Location: **Director's Row H**

The recent past has witnessed an explosion of activity in Artificial Intelligence (AI) and Machine Learning (ML). AI/ML is easily the most "disruptive" technology of contemporary society. Yet much of

the claimed progress rests on simulations that are not always repeatable, or fragile against small perturbations in parameters, or both. Consequently, the AI/ML community has begun to show some interest in developing some theoretical foundations for the subject. In response to this, the organizers of this tutorial session propose a session consisting of three forty-minute talks, all of them by leading experts in control and system theory who have also made substantial contributions to learning.
The objectives of the session are:

- To give the audience a sense of the opportunities for persons trained in control and system theory to contribute to the growth of AI/ML.
- To give a glimpse of the research frontier in these areas that can be successfully tackled using control / system theory, or allied approaches.

Presenters: Mathukumalli Vidyasagar, **Mathematical foundations of deep and reinforcement learning**
George Pappas and Manfred Morari, **Robustness analysis of neural networks via semidefinite programming**
Pramod Khargonekar, **Neuro-cognitive science inspired learning control architectures and algorithms**