



April 22 - 23, 2010
Beckman Institute
University of Illinois

Welcome to the 2nd symposium in the series on *Emerging Topics in Control and Modeling*. In 2010, we focus on research topics at the intersection of control, modeling, and biomedical systems.

The program features 12 invited presentations from field experts. Additionally, an Interactive Session will highlight recent research from graduate students. The program concludes with a panel session to garner expert opinion on the ideas presented at the symposium and investigate future directions.

We would like to thank the staff at the Beckman Institute and Coordinated Science Lab who have given their time to support the symposium, and the sponsors who have made this possible. Furthermore, we would like to thank the invited speakers and attendees who have helped make this event a success.

With regards,
The Organizing Committee

Hosts:
The Beckman Institute and Coordinated Science Lab

Technical Co-Sponsors:
IEEE Control Systems Society
ASME Dynamic Systems & Control Division

Schedule

Thursday, April 22, 2010*

7:30 - 8:30 am *Breakfast and Registration*, 1005 Beckman

8:30 - 9:00 am *Opening Remarks and Overview*

Organizing Committee

William Sanders: Interim Director of the
Coordinated Science Laboratory

9:00 - 10:00 am *Artificial Pancreas*, Frank Doyle

10:00 - 11:00 am *Evaluating Treatment*, Antonios Armaou

11:00 - 12:30 pm *Lunch*, 1005 Beckman

12:30 - 1:30 pm *Noninvasive Ultrasound*, Emad Ebbini

1:30 - 2:30 pm *Graph Segmentation*, Milan Sonka

2:30 - 3:00 pm *Break*, 1005 Beckman

3:00 - 4:00 pm *Polio Epidemiology*, James Koopman

4:00 - 5:00 pm *Parkinson's Disease*, Sridevi Sarma

5:00 - 7:00 pm *Interactive Session*, Beckman Atrium

Friday, April 23, 2010*

7:30 - 8:00 am *Breakfast*, 1005 Beckman

8:00 - 9:00 am *Experiment Design*, Ann Rundell

9:00 - 10:00 am *Neural Motor Control*, Levi Hargrove

10:00 - 10:30 am *Break*, 1005 Beckman

10:30 - 11:30 am *Exoskeleton Systems*, Homayoon
Kazerooni

11:30 - 12:30 pm *NMR and MRI*, Jr-Shin Li

12:30 - 2:00 pm *Lunch*, 1005 Beckman

2:00 - 3:00 pm *Predicting Toxicity*, Mathukumalli
Vidyasagar

3:00 - 4:00 pm *Ultrasound Applications*, Kai Thomenius

4:00 - 4:30 pm *Break*, 1005 Beckman

4:30 - 5:30 pm *Panel Discussion and Closing Remarks*

* Events to be held in Beckman Auditorium unless otherwise noted

Invited Speakers: Thursday April 22, 2010

9:00 - 10:00 am ○ **Frank Doyle** ○ *The Role of Process Systems Engineering in the Quest for the Artificial Pancreas*

Prof. Doyle is the Associate Dean for Research in the College of Engineering at UC, Santa Barbara and he is the Associate Director of the Army Institute for Collaborative Biotechnologies. He holds the Duncan and Suzanne Mellichamp Chair in Process Control in the Department of Chemical Engineering, as well as appointments in the Electrical Engineering Department, and the Biomolecular Science and Engineering Program. He received his B.S.E. from Princeton (1985), C.P.G.S. from Cambridge (1986), and Ph.D. from Caltech (1991), all in Chemical Engineering. Prior to his appointment at UCSB, he has held faculty appointments at Purdue University and the University of Delaware, and held visiting positions at DuPont, Weyerhaeuser, and Stuttgart University. His research interests are in systems biology, network science, modeling and analysis of circadian rhythms, drug delivery for diabetes, model-based control, and control of particulate processes.

10:00 - 11:00 am ○ **Antonios Armaou** ○ *Evaluating Treatment Strategies for Viral Infections and Tumors Using Multiscale Simulation*

Prof. Armaou Antonios Armaou was born in Athens, Greece, in 1972. He received the Diploma in Chemical Engineering degree from the National Technical University of Athens, Greece, in 1996, and the Ph.D. degree in Chemical Engineering from the University of California at Los Angeles, in 2001. From 2001 to 2002, he held a postdoctoral research position at Princeton University, after which he joined the faculty of the Chemical Engineering department at Pennsylvania State University where he currently is an associate professor and a faculty member to the Operations Research graduate program. His theoretical research focuses on the development of computationally efficient model reduction, optimization and control methodologies for nonlinear distributed parameter and multiscale process systems. Applications in the areas of advanced materials and semiconductor processing and nanofabrication, as well as biomedical systems (i.e., viral infections and tumor growth) compliment his theoretical interests.

12:30 - 1:30 pm ○ **Emad Ebbini** ○ *Realtime Control of Multiple-Focus Phased Array Heating Patterns Based on Noninvasive Ultrasound Thermography*

Prof. Ebbini received his B.Sc. in EE/communications in 1985 from the University of Jordan, and his M.S. and Ph.D. in EE from the University of Illinois at Urbana-Champaign in 1987 and 1990. From 1990 until 1998, he was on the faculty of the EECS department at the University of Michigan Ann Arbor. Since 1998, he has been with the ECE department at the University of Minnesota, where he is currently a Professor. He is currently an Associate Editor of the IEEE Transactions

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on Biomedical Engineering. Prof. Ebbini is a member of the Standing Technical Program Committee for the IEEE Ultrasonics Symposium and a member of the Board of the International Society for Therapeutic Ultrasound. His research interests are in signal and array processing with applications to biomedical ultrasonics and medical devices.

1:30 - 2:30 pm ○ **Milan Sonka** ○ *Multi-Object Multi-Surface Optimal Graph Segmentation*

Prof. Sonka Milan Sonka received his Ph.D. degree in 1983 from the Czech Technical University in Prague, Czech Republic. He is Professor and Chair of the Department of Electrical & Computer Engineering, Professor of Ophthalmology & Visual Sciences, and Radiation Oncology at the University of Iowa, Co-director of Iowa Institute for Biomedical Imaging, IEEE Fellow, and AIMBE Fellow. His research interests include medical imaging and knowledge-based image analysis with emphasis on cardiovascular, pulmonary, orthopedic, and ophthalmic image analysis. He is the first author of 3 editions of Image Processing, Analysis and Machine Vision book (1993, 1998, 2008). He is Editor in Chief of the IEEE Transactions on Medical Imaging, member of the Editorial Board of the Medical Image Analysis journals. Dr. Sonka is co-founder of VIDA Diagnostics, a start-up company developing novel image-analysis tools for comprehensive quantitative assessment of pulmonary morphology and function and co-founder of Medical Imaging Applications, LLC, a company that develops and markets cardiovascular ultrasound image analysis research and clinical-care software.

3:00 - 4:00 pm ○ **James Koopman** ○ *Complex Dynamics of Polio Transmission and Immunity and the Failure of High Vaccination Rates to Eliminate Transmission in Northern India*

Prof. Koopman started his career as a pediatrician in 1969, then joined the epidemic intelligence service and became acting state epidemiologist in the State of Washington and then a smallpox eradicator in northern India. That was followed by an MPH in epidemiology and several years of work in Latin America before joining the faculty at the University of Michigan in 1978. From 1984-6 he set up an epidemiology program in Mexico under the auspices of the US CDC and thereafter changed careers from a field epidemiologist to a mathematical modeler and theoretician. His theoretical focus has been on how dynamic system analysis which takes contact patterns into account can be used to make robust inferences that serve Public Health. His currently funded work includes 1) the analysis of modes of transmission for influenza and methicillin resistant Staph aureus (MRSA) in hospitals, 2) developing methods to use genetic sequences of infectious agents to analyze their transmission systems, 3) determining how much HIV transmission occurs before people become HIV positive and the aspects of contact patterns that increase that, and 4) why polio is not being eradicated in northern India.

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4:00 - 5:00 pm ○ **Sridevi Sarma** ○ *To Cue or Not to Cue: Reframing the Question for Parkinson's*

Prof. Sarma received the B.S. degree in electrical engineering from Cornell University, Ithaca NY, in 1994; and an M.S. and Ph.D. degrees in Electrical Engineering and Computer Science from MIT in 1997 and 2006, respectively. She was a Postdoctoral Fellow in the Brain and Cognitive Sciences Department at MIT from 2006-2009. She is now an assistant professor in the Institute for Computational Medicine, Department of Biomedical Engineering, at Johns Hopkins University, Baltimore MD. Her research interests include modeling, estimation and control of neural systems. She is a recipient of the GE faculty for the future scholarship, a National Science Foundation graduate research fellow, a L'Oreal For Women in Science fellow, and a recipient of the Burroughs Wellcome Fund Careers at the Scientific Interface Award.

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8:00 - 9:00 am ○ **Ann Rundell** ○ *Quantitative Experiment Design for Highly Uncertain Biological Systems*

Prof. Rundell is an assistant professor in the Weldon School of Biomedical Engineering at Purdue University. She received her BS in Electrical Engineering from the University of Pennsylvania. Prior to graduate school, Ann worked for three years at Artel, Inc. in Windham, Maine as an engineer designing small portable photometric instrumentation systems for the clinical and environmental marketplaces. Eventually Ann returned to school to earn her MS and PhD degrees from the School of Electrical and Computer Engineering at Purdue University. Her graduate research was on modeling and control of the immune system. Upon completion of her PhD she worked at MIT Lincoln Laboratory as a member of the Technical Staff for three years prior to joining academia as a faculty member. Her research interests apply systems and control theory to control cellular and physiological processes for developing and designing diagnostics and therapeutics.

9:00 - 10:00 am ○ **Levi Hargrove** ○ *Towards Clinically Viable Neural Control of Powered Arms and Legs*

Dr. Hargrove received his B. Sc. and PhD in Electrical Engineering from the University of New Brunswick in Fredericton, New Brunswick, Canada in 2003 and 2008 respectively. Dr. Hargrove's research focuses on developing clinically robust pattern recognition myoelectric control systems for both upper and lower limb amputees. Dr. Hargrove joined Todd Kuiken's the Neural Engineering Center for Artificial Limbs at the Rehabilitation Institute of Chicago in 2008 to lead a US Army Telemedicine and Advanced Technology Center (TATRC) sponsored research project to develop a neural interface for powered lower limb prosthetics.

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Dr. Hargrove is an Assistant Research Professor in the Department of Physical Medicine and Rehabilitation at Northwestern University's Feinberg School of Medicine.

10:30 - 11:30 am ○ **Homayoon Kazerooni** ○ *Lower Extremity Exoskeleton Systems for Medical Applications*

Prof. Kazerooni holds a Doctorate in Mechanical Engineering from MIT and is currently a Professor in the Mechanical Engineering Department at the University of California, Berkeley. Dr. Kazerooni is the director of the Berkeley Robotics and Human Engineering Laboratory. He has published over 180 articles on Robotics, Control Sciences, Artificial Locomotion, Assist Devices and Mechatronics. He is the holder of twenty pertinent patents where most of them have been licensed. Dr. Kazerooni has served in a variety of leadership roles in the robotics community; served as associated editor of two journals: ASME Journal of Dynamics Systems and Control and IEEE Transaction on Mechatronics. Dr. Kazerooni was the recipient of the outstanding ASME Investigator Award, Discover Magazine Technological Innovation Award, and the McKnight-Land Grant Professorship. His research was recognized as the most innovative technology of the year in New York Times Magazine; December 2004. Dr. Kazerooni is also the founder and CTO of Berkeley Bionics which designs and manufactures lower extremity exoskeletons to augment human strength and endurance during locomotion.

11:30 - 12:30 pm ○ **Jr-Shin Li** ○ *Ensemble Control and Computation: From Quantum Mechanics to Neuroscience*

Prof. Li received his BS and MS degrees from National Taiwan University, and his PhD degree in Applied Mathematics from Harvard University in 2006. He is currently an Assistant Professor in Electrical and Systems Engineering with joint appointment in the Division of Biology and Biomedical Sciences at Washington University in St. Louis. His research interests are in areas of control theory, optimization, and computational mathematics with applications ranging from quantum mechanics and neuroscience to bioinformatics. He is a recipient of the NSF Career Award in 2007 as well as the AFOSR Young Investigator Award in 2009.

2:00 - 3:00 pm ○ **Mathukumalli Vidyasagar** ○ *Predicting Adverse Events in Clinical Trials: A Nonstandard Problem in Statistical Learning?*

Prof. Vidyasagar received the B.S., M.S. and Ph.D. degrees in electrical engineering from the University of Wisconsin in Madison, in 1965, 1967 and 1969 respectively. Between 1969 and 1989, he was a Professor of Electrical Engineering at various universities in the USA and Canada. This concluded with the University of Waterloo, ON, Canada, where he served between 1980 and 1989. In 1989 he

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returned to India as the Director of the newly created Centre for Artificial Intelligence and Robotics (CAIR) in Bangalore, under the Ministry of Defence, Government of India. In 2000 he moved to the Indian private sector as an Executive Vice President of India's largest software company, Tata Consultancy Services. In 2009 he retired from TCS and joined the Erik Jonsson School of Engineering & Computer Science at the University of Texas at Dallas, as a Cecil & Ida Green Professor of Systems Biology Science. In his latest incarnation, he conducts teaching and research in two distinct areas: computational biology and quantitative finance. He is now the Head of the newly created Bio-Engineering Department at UT Dallas.

3:00 - 4:00 pm ○ **Kai Thomenius** ○ *New Applications for Medical Ultrasound Scanners*

Dr. Thomenius received his PhD degree from Rutgers University in Electrical Engineering and Physiology. He is currently a Chief Technologist in the Imaging Technologies Organization of GE Global Research in Niskayuna, NY. He is also an Adjunct Professor in the Electrical and Computer Science and Engineering department at Rensselaer Polytechnic Institute in Troy, NY. Prior to joining GE, he has worked for several medical ultrasound companies in senior R&D roles and holds about two dozen patents for medical ultrasound scanners. Dr. Thomenius' current activities focus on development of instrumentation and applications for newly evolving imagers such as ultrasound scanners and other forms of bioinstrumentation. He is a Fellow of the American Institute of Ultrasound in Medicine and has received the Coolidge Fellowship of the GE Global Research.

Interactive Session

Restoring the Basal Ganglia in Parkinson's Disease to Normal via Multi-Input Phase Shifted Deep Brain Stimulation

Rahul Agarwal

Johns Hopkins University

Remote Teleoperation of an Unmanned Aircraft with a Brain-Machine Interface

Abdullah Akce, Miles Johnson, Or Dantsker, Timothy Bretl

University of Illinois at Urbana-Champaign

Unmatched Muscle Power: Mapping Physiological Control to Virtual World Physics

Bradly Alicea

Michigan State University

Modeling Mitochondrial Permeability Transition at the Mitochondrial Population Bioenergetics Level

Jason Bazil

Purdue University

Integrative Systems Modeling Identifies Novel Drug Targets for Tuberculosis

Sriram Chandrasekaran, Nathan Price

University of Illinois at Urbana-Champaign

Encoding and Decoding Finger and Wrist Movements from M1 Neurons in 1 Primate using Point Process Models

Liang-hui Chu

Johns Hopkins University

Constrained Kalman Filtering for IMRT Planning

Isuru Dasanayake

Washington University in St. Louis

Neuromuscular Control Adaptation in Gait Due to Injury: A Motivating Study using a Simplified Dynamic Model

Louis DiBerardino

University of Illinois at Urbana-Champaign

Automatic Recognition of Apoptosis in Cancer Cell Image

Liu Hailing

Chosun University

Interactive Session

Anatomical Landmark Based Analysis of the Corpus Callosum Abnormalities in Essential Autism

Qing He

University of Missouri

Electromyographic Analysis of the Pelvic Limb Muscles of Healthy Labrador Retrievers

Mei Kuen Hsu, Chantal Ragetly

University of Illinois at Urbana-Champaign

Real-time Heart Model for Implantable Cardiac Device Validation and Verification

Zhibao Jiang

University of Pennsylvania

Learning-Reasoning Lattices in Telehealth

Stanley Jointer II, Lakshman Tamil, Gopal Gupta

University of Texas at Dallas

Quantitative Ultrasound for Monitoring and Assessment of Thermal Therapy

Jeremy Kemmerer, Goutam Goushal, William Ridgway, Michael Oelze

University of Illinois at Urbana-Champaign

Inverse Dynamics Gait Analysis of the Pelvic Limbs of Healthy Labrador Retrievers

L. Michaela Klump, Chantal Ragetly, Elizabeth Hsiao-Weckler

University of Illinois at Urbana-Champaign

Contribution of Passive Properties of Muscle-Tendon Units to the Metacarpophalangeal Joint Torque of the Index Finger

Pei-Hsin Kuo

University of Maine

Noninvasive Brain Imaging of Awake and Anesthetized Songbirds Hearing Natural Stimulus

James Lee, Edward Maclin, Gabriele Gratton, Monica Fabiani, David Clayton

University of Illinois at Urbana-Champaign

Modeling and Control of A Pneumatic Power Ankle Foot Orthosis

Yifan Li

University of Illinois at Urbana-Champaign

Interactive Session

A Hidden Markov Model and Analytic Spatial Filter for Enhanced Information Transfer Rates in EEG-Based Brain-Computer Interfaces

Martin McCormick, Rui Ma, Todd Coleman
University of Illinois at Urbana-Champaign

Adaptive Model Predictive Control of Human Promyelocytic Leukemia Cell Differentiation

Sarah Noble
Purdue University

Image Driven Modeling of Neuromuscular Control of Speech

Thomas Paine
University of Illinois at Urbana-Champaign

Brat-Mediated Bi-Stability and Cell-Competition Autoregulate Stem Cell Number in the Drosophila Germarium

Michael Pargett
Purdue University

Assessing Spatiotemporally Complex and Coupled Gait Patterns using Temporal Cross-Correlation

Kiwon Park
University of Illinois at Urbana-Champaign

Modeling of Cellular Differentiation upon Hematopoietic Stem Cell Transplantation

Serena Pearce, Ann Rundell
Purdue University

Preliminary Investigations into Multiple-Model Input Design for Controlling Intracellular Signaling Dynamics

Jeffrey Perley, Maia Donahue, Gregory Buzzard, Ann Rundell
Purdue University

L1 Adaptive Methods for Control of Patient Response to Anesthesia

Matthew Ralph
University of Illinois at Urbana-Champaign

A Universal Computational Method for Pulse Sequence Design

Justin Ruths
Washington University in St. Louis

Interactive Session

Point Process Modeling of Cortical Spiking Activity in Normal and MPTP Primates during Deep Brain Stimulation

Sabato Santiniello

Johns Hopkins University

Using Point Process Models to Describe the Cortico-Striatal and Pallido-Striatal Dependencies in Healthy Primates

Sabato Santiniello

Johns Hopkins University

Point Process Models show Temporal Dependencies of Basal Ganglia Nuclei under Deep Brain Stimulation

Shreya Saxena

Johns Hopkins University

Compensating Input Delay and Muscle Fatigue during Neuromuscular Electrical Stimulation Control

Nitin Sharma

University of Florida

A Portable-Powered Ankle-Foot Orthosis for Rehabilitation

Alex Shorter

University of Illinois at Urbana-Champaign

Evolutionary Game Theoretical Approach for Controlled Drug Delivery: Theory and Experimental Results

Jing Wu

University of Tennessee

Modeling and Simulation of Intravascular Drug Delivery from a Drug-Eluting Stent

Xiaoxiang Zhu

University of Illinois at Urbana-Champaign

Panel Discussion Members

Prof. Stephen Boppart

*Department of Electrical and Computer Engineering
University of Illinois, Urbana, IL*

Prof. Timothy Bretl

*Department of Aerospace Engineering
University of Illinois, Urbana, IL*

Prof. Harry Dankowicz

*Department of Mechanical Science and Engineering
University of Illinois, Urbana, IL*

Dr. Levi Hargrove

Rehabilitation Institute of Chicago, Chicago, IL

Dr. Kai Thomenius

GE Global Research, Niskayuna, NY

Acknowledgements

We would like to thank the following people for their help and guidance throughout the organization of this Symposium

Administration, Logistics, and Publicity

Becky Lonberger

Jana Lenz

Prof. William Sanders

Beth Dennison

Sue Johnson

Kathy Harper

Denise Lewis

Prof. Victoria Coverstone

Prof. Andreas Cangellaris

Prof. Larry Schook

Rick Valentin

Aaron Cohen

Jim Farrar

Chris Roberts

Faculty Advisers

Andrew Alleyne

Tamer Başar

Stephen Boppart

Timothy Bretl

Todd Coleman

Zhi-Pei Liang

Sean Meyn

William O'Brien

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Ashlee Ford

Robert Gregg

David Hoelzle

Miles Johnson

Jeremy Kemmerer

University of Illinois Engineering Campus Map

