The Power, Beauty and Excitement of a Field that Spans Science, Technology, Engineering and Mathematics

This workshop is held in conjunction with the 2009 American Control Conference

Open to all participants of ACC 2009

3:00 -7:30 pm, Tuesday, June 9, 2009
Ballroom E, Hyatt Regency, St. Louis, MO

Sponsored by: IEEE CSS and AACC Technical Committees on Control Education, NSF, and University of Kansas

Organizers: Bozenna Pasik-Duncan, University of Kansas and Shirley Dyke, Washington University

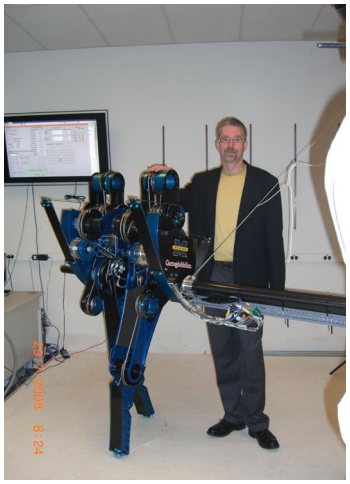
Assisted by: Dominique Duncan, Yale University

The purpose of this workshop is to increase the general awareness of the importance of systems and control technology and its cross-disciplinary nature among high school teachers and students. The workshop activities include presentations by control scholars and remarkable speakers, informal discussions, and the opportunity for teachers to meet passionate researchers and educators from academia and industry. The talks are designed to be educational, inspirational and entertaining showing the excitement of being an engineer.

Presentations include:

Giving Bipedal Robots a Sense of Balance
Jessy Grizzle, Jerry and Carol Levin Professor of Engineering
Control Systems Laboratory, Electrical Engineering & Computer Science Department
University of Michigan, Ann Arbor

This talk discusses research that is being done to give robots the same sense of balance that humans posses. Several machines that have been investigated will be presented. How this fascinating subject can be tied to high school physics will be outlined. The talk is liberally illustrated with graphics and videos that explain and support the research being done. Web: http://www.eecs.umich.edu/~grizzle/



Prof. Grizzle with MABEL.

What Can Optimal Control Tell Us About Cancer Treatments?
Urszula Ledzewicz, (Speaker)
Department of Mathematics and Statistics,
Southern Illinois University Edwardsville, Edwardsville

Heinz Schättler,
Department of Electrical and Systems Engineering,
Washington University, St. Louis, Missouri

In the talk we shall discuss some models describing the dynamics of cancer growth under various treatments including both traditional ones like chemotherapy and novel treatment approaches like tumor anti-angiogenesis (a therapy that prevents the vascularization of a growing tumor) as well as combinations of both. We shall show how stating this dynamics with the dosage of the drug playing the role of the control and the objective of minimizing the tumor size at the end of the process while keeping limits on the amount of the drugs administered and its eventual toxicity leads to various versions of optimal control problems that can be analyzed. The biological interpretation of the obtained results provides information on how to design both optimal and excellent suboptimal treatment protocols. These protocols are relatively difficult, or at least very expensive to test in a laboratory setting, particularly if more than one drug is involved.

Epileptic seizures: Quakes of the Brain?

Ivan Osorio, M.D., Professor (Speaker)
Department of Neurology,
University of Kansas Medical Center, Kansas City, KS

Mark Frei, Ph.D.
Flint Hills Scientific, LLC, Lawrence, KS

Didier Sornette, Professor
Department of Management, Technology and Economics,
ETH-Zurich, Switzerland

John Milton, Professor
Joint Science Departments, The Claremont Colleges,
Claremont, CA

Ying Cheng Lai, Professor
Electrical Engineering, Arizona State University, Tempe

An analogy supported by four scale-free statistics (Gutenberg-Richter distribution of event sizes, Omori and inverse Omori laws and conditional waiting time till the next event), is shown to exist between seizures (SZ), and earthquakes. However, deviations from power law behavior (characteristic scales) were observed. Since coupling strength shapes the probability distribution function of event sizes in threshold oscillator systems, its role was investigated in animals. Increases in excitatory interneuronal coupling causes the SZ power law regime to become coextensive with a characteristic scale one. This coextensivity is consistent with and predicted by models of coupled threshold oscillators of relaxation. The evidence for both "Omori-like" laws and the long-memory associated with the heavy-tail inter-event times distribution, suggests the existence of temporal dependencies between SZ and of predictable dynamics.

Introducing K-12 Students to the Math and Communication of Engineering

C.J. DeGroot, STEM Fellow
Mechanical, Aerospace and Structural Engineering Department
Washington University, Saint Louis, Missouri

This talk discusses a GK12 fellow's experiences teaching structural engineering concepts in a 6th grade classroom. Discussions will focus on teaching the math and physics involved in the analysis of a truss bridge and learning to communicate through experiences with earthquake hazard mitigation and the 2004 Indian Ocean tsunami. http://www.seas.wustl.edu/gk12 /

Earthquake Engineering in the High School Classroom

Jeffrey Mitchell, STEM Fellow
Mechanical, Aerospace and Structural Engineering Department
Washington University, Saint Louis, Missouri

This talk discusses how instructional shake tables can be used to introduce high school students to the basics of earthquake engineering as well as excite them about opportunities in engineering. Suggestions for implementing this program into high school curriculum will be outlined. The importance involving universities in young student's exploration of science, technology and opportunities in higher education will also be stressed. http://www.seas.wustl.edu/gk12 /

Using LEGO® Robots to Promote STEM Careers In Middle-School

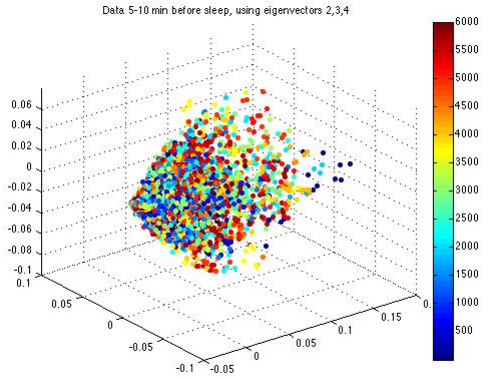
Jose Lopez and Kevin Derendorf, STEM Fellows
Electrical and Systems Engineering Department
Mechanical, Aerospace and Structural Engineering Department
Washington University, Saint Louis, Missouri

This talk will describe the experiences of two STEM Fellows in using LEGO robots to promote STEM careers to 8th graders at Brittany Woods Middle School. The talk includes discussion on some of the challenges faced by the Fellows, some of the successes (and failures), as well as, future module adaptations to be tried in the fall. Visual materials relating these enlightening experiences will be provided. http://www.seas.wustl.edu/gk12 /

The Brain as a Platform for Integrating Science, Technology, Engineering and Mathematics (STEM)

Dominique Duncan[1] (Speaker), Ronald Coifman[2], Hitten Zaveri[3]
[1]Electrical Engineering, [2]Mathematics and Computer Science, [3]Neurology
Yale University

This poster presentation focuses on the Detection of Anomalies in Intracranial EEG Data Using Diffusion Geometry. Intracranial EEG (icEEG) data are recorded from patients for evaluation for epilepsy surgery. The focus has been on using diffusion geometry for the detection and prediction of seizures from these data. A possibly powerful way of analyzing EEG data is by using diffusion mapping. With this method, eigenfunctions of Markov matrices are used to construct coordinates that generate efficient representations of complex geometric structures. Initially, a matrix describing local affinities is constructed and then normalized to become a Markov matrix. Selected eigenfunctions of this matrix are chosen to make the diffusion map embedding in a lower dimensional Euclidean space. Not only does diffusion mapping allow for dimensionality reduction of the data, but this method also provides pattern recognition so that specific parts of the data may be analyzed more closely. Diffusion maps extend principal components analysis and provide a nonlinear approach. The geometry of the data in the diffusion mapping is used to detect anomalies and to determine if there are any anomalies that may help predict the occurrence of a seizure. Analysis was performed on five channel icEEG data. The analysis suggests that diffusion maps of intracranial EEG data show promise as an indicator and possibly as a predictor of the occurrence of seizures. Diffusion maps were used to distinguish resting state or baseline data that is recorded at some time prior to the occurrence of a seizure to data recorded immediately prior to the occurrence of a seizure. This presentation shows the importance of integrating science, technology, engineering and mathematics in this interdisciplinary research.



Careers in Mechatronics and Controls

Mark W. Spong, Dean
Erik Jonsson School of Engineering and Computer Science
Lars Magnus Ericsson Chair and the Excellence in Education Chair in Electrical Engineering
University of Texas at Dallas , Richardson

In this talk we will discuss the emerging area of mechatronics and it's application to robotics and control. Mechatronics deals with the integration of mechanical systems, electronics, computer science and control. Many systems, such as automobiles, airplanes, robots and medical devices are examples of mechatronic systems. We will discuss several interesting mechatronics projects that we have designed and built over the years, including self-balancing robots and a robot that plays air hockey against a human. Such projects can prepare students for interesting and exciting careers in engineering.

Panel Discussion

Can Control Engineering Play an Important Role in STEM Education?
What Can We Do Better to Attract More American Students to STEM Education?
Moderators: Shirley Dyke and Bozenna Pasik-Duncan
Panelists include: Fahmida Chowdhury, NSF Director, Graduate-K12 Fellows from Washington and Kansas Universities, graduate students, speakers, and teachers.