Colloquia

Archives: Spring 2016

Department of Electrical and Computer Engineering Colloquia: Tufts University

Halligan Hall, Fridays from 1:30pm to 2:45pm (refreshments at 1:20, talk begins at 1:30) unless otherwise noted.

All seminars are open to the public. Our seminars are a great opportunity to see the results of exciting new research by faculty, students, or other institutions, or just to get a sense of what the ECE Department is all about. For comments or questions, or if you would like to receive email notifications of upcoming colloquia, please send us an email.

Organizers: Shuchin Aeron and Tom Vandervelde

January 29, 2016
Halligan 102
Compressive sensing based high resolution array imaging
Speaker: Dr. Dehong Liu, Mitsubishi Electric Research Labs (MERL)

Abstract:
High resolution radar imaging has been an interesting topic for decades. In real applications, radar imaging resolution may be restricted by cluttered background, physical array aperture size, total number of antennas, etc. In this talk, I will address these issues with compressive sensing (CS) based imaging methods in multiple applications. The relationship between CS-based imaging and high-resolution time-reversal imaging will also be discussed. Joint work with Petros T. Boufounos and Ulugbek Kamilov.

February 5, 2016
Halligan 102
Computational Imaging — Breaking the limitations of conventional imaging designs
Speaker: Dr. Aswin Sankaranarayanan, Carnegie Mellon University

Abstract:
The basic design of the camera — a lens and an imaging sensor — has remained unchanged for many centuries. While this design has been perfected for professional photography, there are many current and upcoming application domains where it is woefully inadequate. I will discuss three such examples: high-resolution imaging in infrared, extremely thin form-factor cameras, and amateur photography. In each example, I will discuss research from my work and others on novel designs that provide capabilities that far exceed those of the conventional design. Central to my talk is the idea of computational imaging — the co-design of optics and processing to break the limitations of conventional imaging designs.

February 12, 2016
Halligan 102
Data Science @ NASA
Speaker: Brian Thomas, NASA

Abstract:
The NASA Office of the Chief Information Officer (OCIO) is engaged with carrying out agency wide projects to tackle Big Data problems. In this introductory talk I'll discuss how Data Science and Big Data are related, who is part of our "Data Team", provide a sampling of the projects which we are engaged in currently or in

the near future and our plans for a new "Data Fellows" program which we are designing to bring in missing Data Science expertise to NASA.

February 19, 2016
Halligan 102
Automating model-building and discovery in solid-state physics
Speaker: Dr. John Thomas, University of California, Santa Barbara

Abstract:
By informing synthesis parameters and elucidating the phenomena that give rise to material properties, computational materials science provides an invaluable tool for materials design and optimization. However, as computational resources become increasingly abundant, new bottlenecks have formed at the 'artisanal' steps of the simulation process, such as posing hypotheses about the structure of a material or building accurate Hamiltonians and free-energy models that account for all relevant symmetries of the problem.

In this talk, I will present ongoing work to systematize the finite-temperature simulation of crystalline materials, starting from first principles, and describe the application of new methods to two materials problems that, until now, have resisted any systematic approach. The first of these is the prediction of the surface-structure stability of III-V alloys, which is an important consideration for controlling diffusion and device characteristics in epitaxially-grown semiconductors. The second is the prediction of finite-temperature stability and mechanical properties of crystal phases that become dynamically unstable at low temperature, such as zirconium hydride, which is an embrittling corrosion product found in the fuel cladding of light-water nuclear reactors.

March 4, 2016
Halligan 102
Atomic Scale Growth Processes of Compound Semiconductor Alloys
Speaker: Dr. Joanna Millunchick, University of Michigan

Abstract:
The growth of semiconductor alloys continues to be an important topic of research as new solutions are being sought for a variety of applications, including infrared sensing, spintronics, and quantum information processing. Our group examines the fundamental physics of the crystal growth mechanisms for III-V compound semiconductor alloys, with a special focus on new materials systems. In this talk I will concentrate on describing the atomic-scale processes that occur during the growth of ternary and quaternary alloys. InAsSbBi, for instance, is an attractive alternative for HgCdTe because of its low band gap. Recently, it's been shown that phase separation in this system may be avoided with appropriate strain relaxation. Achieving the desired composition, however, requires a deep understanding of the complex kinetic interactions between the anion species. Another important aspect to understand is the atomic surface structure of the growth front. Ab initio calculations show that the most stable surface reconstructions are not necessarily stoichiometric with the bulk, which can result in point defect injection or even the nucleation of liquid metal droplets. While their formation may lead to compositional variations across the thickness of the film, these metal droplets may also be exploited to form novel nanostructures even in the absence of lattice mismatch strain. Kinetic Monte Carlo simulations that explicitly take the group III and group V species into account elucidate the kinetic processes responsible for their formation, and predict new structures that have yet to be reported experimentally.

March 11, 2016
Halligan 102
Discovering the properties of biological systems through modern control theory approaches
Speaker: Dr. Maja Skataric, Schlumberger-Doll Research Center

Abstract:
In this talk I will discuss various techniques related to modeling and identification problems arising in complex biological networks, and demonstrate how control theory approaches can be used to validate mathematical models coming from exhaustive computational experiments or noisy experimental data. ! An important phenomenon in biology is that in which a physiological signal returns to a pre stimulus or "default" value after a transient input has been sensed. This input might be physical or biochemical, such as a light input to a photoreceptor, or a ligand to an olfactory receptor. Often, a return to such steady state values of outputs occurs even in the face of a sustained step or periodic excitation: the study of such exact or approximate adaptation to a persistent input has been the subject of extensive investigations in both the experimental and the modeling literature. It has been recently observed that some adapting systems, ranging from bacterial chemotaxis pathways to signal transduction mechanisms in eukaryotes exhibit an additional feature: scale invariance, meaning that transient behavior remains approximately the same when the background signal level is scaled. I will review the biological phenomenon and formulate a theoretical framework for a class of enzymatic networks. The theorem allows one to make testable predictions and I will discuss the validation of these predictions using genetically engineered bacteria and microfluidic devices. Finally, I will discuss the development of the tools for the identification of time-varying parameters in nonhomogeneous Poisson processes, in applications where discrete measurements such as "spikes" or "tumbles" are observed from the behavior of free-swimming bacteria in response to the nutrient (input) signals. The objective is to estimate the underlying rate of a nonhomogeneous Poisson process that describes these events, which can then be used to analyze the input- output relationship and postulate a plausible model.

April 1, 2016
Halligan 102
"Anything you're good at?" A physicist's adventures from Medford to NASA by way of the South Pole
Speaker: Todd Gaier, Ph.D., Jet Propulsion Laboratory, NASA

Abstract:
Fresh with a BS in Physics from Tufts, I set out to Santa Barbara, CA to obtain a Ph.D. A serendipitous arrival of a new Assistant Professor introduced me to the wonders of Experimental Cosmology. I had the good fortune to study the Cosmic Microwave Background during a time of great discovery, when I learned to build specialized radio telescopes and operate them from the South Pole and remote mountaintops. These observations eventually took my studies to space and a career at NASA's Jet Propulsion Laboratory. There I developed receiver technologies and instrumentation for astrophysics missions including ESA's Planck and Herschel satellites. I turned my attention to Earth science and using similar receiver technologies, began a second career in microwave remote sensing. At JPL I run a group of 20 scientists, engineers and technicians and together we have developed technologies and space instruments for missions including Jason-2 and 3, and Juno- which will reach Jupiter on July 4.

April 8, 2016
Halligan 102
Compressive Imaging with Learning Optical Tomography
Speaker: Ulugbek S. Kamilov, Ph.D.

Abstract:
In optical tomography, an object is illuminated with with various input patters and the scattered field is holographically recorded, giving access to both the amplitude and the phase of the light field at the camera plane. The image of the object is then numerically formed from the measurements, using computational inverse scattering methods that rely on physical models describing the object-wave interaction. In this talk, we present a new computational imaging method to image objects from scattered light-fields. Our method is based on a nonlinear physical model that can account for multiple scattering in a computationally efficient way. Specifically, we prose to interpret the propagation of light through object, as an artificial multi-layer neural network, whose adaptable parameters correspond to the voxel values of the 3D object. Training the

network to reproduce the experimentally recorded input-output light-field pairs yields the 3D image of the object. Results suggest that this learning approach yields an image quality better than other tomographic reconstruction methods.

April 15, 2016
Halligan 102
An explicit bound on the convergence rate of the Over-Relaxed Alternating Direction Method of Multipliers
Speaker: Jose Bento, Ph.D., Boston College

Abstract:
The framework of Integral Quadratic Constraints of Lessard et al. (2014) reduces the computation of upper bounds on the convergence rate of optimization algorithms to proving the stability of nonlinear feedback systems by solving a semi-definite program (SDP). The work of Nishihara et al. (2015) applies this technique to the entire family of over-relaxed Alternating Direction Method of Multipliers (ADMM). Unfortunately, they only provide an explicit error bound for sufficiently large values of some of the parameters of the problem, leaving the computation for the general case as a numerical SDP. In this talk we start by reviewing the work of Lessard et al. (2014) and Nishihara et al. (2015). Then we show an exact analytical solution to this SDP and obtain a general and explicit upper bound on the convergence rate of the entire family of over-relaxed ADMM. Furthermore, we demonstrate that it is not possible to extract from this SDP a general bound better than ours. Finally, we end with a few numerical illustrations of our result and a comparison between the convergence rate we obtain for the ADMM with known convergence rates for the Gradient Descent and Nesterov's accelerated method.

April 22, 2016
Halligan 102
Designing and micro/nano-fabricating portable impedance-based point-of-care biosensors
Speaker: Dr. Jie Chen , Ph.D., University of Alberta

Abstract:
Companion diagnostics are central to the success of personalized medicine. The portable glucose sensor is indeed the most successful example of a companion diagnostic device. They are used by millions of diabetics worldwide to monitor their health and help make decisions about their medication usage. Building from this example, the lecturer will present the power of metabolomics to develop a collection of multiplexed companion diagnostic systems on a unified platform that can be used to diagnose, monitor, or predict multiple diseases. Metabolomics is an emerging field of "omics" science. Metabolites are very sensitive to gene-environments or gene-pathogen interactions. In this talk, the lecturer will discuss their impedance-based biosensor design to measure not just one metabolite, but dozens or even hundreds at a time from human body fluids (such as blood, urine). The testing time is within 10 minutes at the cost of $1 US Dollar per metabolite test. The sensor is also able to detect metabolites at the concentration of nM. To avoid "false positive", a competitive assay design was applied. Such a platform technology can be easily extended for environmental monitoring, food-safety checking, cancer screening and infectious disease diagnosing.

This talk is sponsored by the IEEE Circuits and Systems Society Distinguished Lecturer program and by the Syracuse Chapter of the CAS Society.

April 29 2016
Halligan 102
Wireless Power Extraction for Biomedical Implants Based on Combining Rectification and DC Voltage Regulation in One Step
Speaker: Dr. Edward Lee , Ph.D., Alfred Mann Foundation

Abstract:
In many biomedical implant systems, power is often delivered wirelessly from an external unit outside the

body across the skin to the implants. The external unit usually consists of a primary coil, which powers the secondary coil inside the implant using inductively coupling. For most of the implant designs, the received AC power on the secondary coil is extracted and converted to DC supply voltages using a rectifier circuit followed by linear voltage regulators. However, using this conventional approach, the overall voltage conversion efficiency and the power conversion efficiency are limited to about low 80%'s due to the voltage drops across the rectifier and the voltage regulators. To improve the overall conversion efficiencies, different approaches to convert the received AC power into regulated DC supply voltages directly in one step will be presented in this talk. Techniques to obtain supply voltages that are higher than the peak voltage of the AC input voltage will also be discussed.