Colloquia

Archives: Fall 2014

Department of Electrical and Computer Engineering Colloquia: Tufts University

Halligan Hall, Tuesdays from 2:50 pm to 4:15 pm (refreshments at 2:50, talk begins at 3:00) 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

September 2, 2014
No Seminar. Intro session/class.

September 9, 2014
Halligan 102
Collective Behavior in Engineered and Social Systems
Speaker: Ali Jadbabaie, Alfred Fitler Moore Professor of Network Science, University of Pennsylvania

Abstract:
Over the past few years there has been a rapidly growing interest in analysis, design and optimization of various types of collective behaviors in networked dynamic systems. In this talk, I will present some of the work that has been going on in my group over the past 10 years on collective phenomena such as flocking, schooling, rendezvous, synchronization, and motion coordination in multi-vehicle systems. The main underlying theme is to study emergence of agreement and consensus in various contexts. Next, I will present a dynamic model of information aggregation and social learning in which heterogeneous agents in a network would like to learn a true state of the world using a stream of private information and opinion exchanges with their neighbors. The information required for learning an unknown state of the world may not be at the disposal of any single agent and individuals engage in communication with their neighbors in order to learn from their experiences. Motivated by the practical difficulties of Bayesian updating of beliefs in a network setting, I will present a simple update mechanism in which instead of incorporating the views of their neighbors in a fully Bayesian manner, agents use a simple updating rule that combines their personal experience and the views of their neighbors. I will characterize bounds on the rate of learning of this model and discuss the relationship between the rate of learning and the quality of observations as well as the location and influence of agents. Finally I will show the implications of the network topology and existence of influential agents on the rate of learning.

Joint work with Pooya Molavi and Alireza Tahbaz-Salehi.

September 16, 2014
3:00–4:15 pm
Halligan 102
Extended Coprime Sensor Arrays and Detection Performance
Kaushallya Adhikari, PhD Candidate, University of Massachusetts Dartmouth

Abstract:
Coprime sensor arrays (CSAs) interleave two uniform linear subarrays that are undersampled by coprime

factors. Two numbers are coprime if they do not have any factor in common other than one. The CSA requires far fewer sensors to match the spatial resolution of a fully populated ULA of the same aperture but the peak side lobe in the CSA is higher than in the fully populated ULA. Adding sensors to the CSA subarrays while keeping the interelement spacings fixed reduces the CSA peak side lobe. Closed form solutions for how many additional sensors a CSA requires to guarantee that the peak side lobe level is not more than the ULA levels for rectangular, Hann, Hamming and Dolph- Chebyshev tapers exist. The CSA processor is non-linear but the PDFs for the CSA detection statistic for both signal present and absent cases are available. The comparison of the ROC plots for the CSA and the full ULA shows that detection gain of a CSA processor is also 10 log10(Number of sensors) over a wide range of sensors and SNRs.

September 23, 2014
3:00–4:15 pm
Halligan 102
Parameter Estimation in Compressive Sensing: The Delay/Doppler Case
Marco F. Duarte, Ph.D., University of Massachusetts Amherst

Abstract:
Compressive sensing (CS) implements simultaneous sensing and compression of sparse and compressible signals based on randomized dimensionality reduction. To recover a signal from its compressive measurements, standard CS algorithms seek the sparsest signal representation in some discrete basis or dictionary that agrees with the measurements. Many applications feature signals that can be represented using a small number of continuous-valued parameters. Such problems have initially been addressed in CS through the design of parametric dictionaries that collect a set of signal observations corresponding to a discretized set of parameter values. These approaches, however, suffer either from resolution limitations due to discretization or from poor performance due to the high coherence of the dictionary, the mismatch between the dictionary and the signal (which may not necessarily be sparse), or both.

September 30, 2014
No Seminar (Open Date)

October 7, 2014
A Method for Large-Scale Distributed Optimization
José Bento, Ph.D., Stanford University

Abstract:
The alternating direction method of multipliers (ADMM) originated in the 1970s as a decomposition-coordination method for solving optimization problems. It has recently had a revival of interest because of its highly distributed and parallel nature. It is typically applied when the objective function can be decomposed into a sum of functions over a set of shared variables that can separately be solved efficiently. ADMM iteratively optimizes each function independently and uses update rules that enforce a consensus among the values of the shared variables. These iterations are specified up to the value of a penalty parameter. In the first part of this talk we revisit ADMM and explain how it can be interpreted as a message-passing algorithm on a bipartite graph. In this interpretation, each message has its own penalty parameter, now called a "message-weight." Informally, these can be seen as measuring the reliability or confidence of the messages. From the intuition gained from our message-passing interpretation, we introduce the Three Weight Algorithm (TWA), a set of rules for dynamically updating the message-weights. The message-weights are restricted to three different values: infinity for absolute confidence, zero for complete lack of confidence and 1 as a default confidence level. This simple change in the algorithm can have an enormous impact on the speed with which it finds solutions for non-convex problems. We demonstrate that TWA can surprisingly quickly solve difficult non-convex problems with a variety of examples. In a first example, TWA is used to solve very large Sudoku puzzles. Here, the infinite weights play a major role and allow the propagation of information through hard constraints. In the second example, TWA is used to pack a very large number of hard disks in a box. Now the zero weights play the major role and speed up convergence

several orders of magnitude compared to standard ADMM. In a third example, we show that TWA can solve difficult multi-robot trajectory planning problems. Finally we conclude by showing that the TWA naturally enables the integration of higher-order knowledge into a lower-level parallel optimization algorithm.

Bio:
José Bento completed his PhD in Electrical Engineering at Stanford University where he worked with Professor Andrea Montanari on statistical inference and structural learning of graphical models. After his PhD, he moved to Disney Research, Boston lab, where he worked with Dr. Jonathan Yedidia on algorithms for distributed optimization, robotics and computer vision. He is now with the Computer Science department at Boston College. His current research lies at the intersection of distributed algorithms and machine learning. In 2011 he received the SIGWEB DocEng Best paper award and won the RecSys-CAMRa2011 Challenge on context-aware recommendation systems. In 2014 he received a Disney Inventor Award for his work on distributed optimization.

October 14, 2014
3:00–4:15 pm
Halligan 102
Cloud Storage Systems: Latency, Reliability, and Cost
Dr. Vaneet Aggarwal, AT&T Labs, Ph.D., Princeton University

Abstract:
Consumers are engaged in more social networking and Ecommerce activities these days and are increasingly storing their documents and media in the online storage. Businesses are relying on Big Data analytics for business intelligence and are migrating their traditional IT infrastructure to the cloud. These trends cause the online data storage demand to rise faster than Moore's Law. Erasure coding techniques are used widely for distributed data storage since they provide space-optimal data redundancy to protect against data loss. Cost-effective, network-accessible storage is a strategic infrastructural capability that can serve many businesses. These customers, however, have very diverse requirements of latency, reliability, cost, security etc. In this talk, I will describe how to characterize latency, reliability, cost, and the trade-offs involved in these. In order to characterize latency, we give and analyze a novel scheduling algorithm. I will describe that limited bandwidth between data centers allow us to design new coding schemes that help improve mean time to data loss of the system by 10^20 for (51,30) erasure code as compared to a standard Reed-Solomon code. Finally, I will focus on joint optimization of customer requirements, present new approaches for content placement and content access, and validate the results using implementations on an open source distributed file system on a public test grid.

Bio:
Vaneet Aggarwal received the B.Tech. degree from the Indian Institute of Technology Kanpur, Kanpur, India, in 2005 and the M.A. and Ph.D. degrees from Princeton University, Princeton, NJ, USA, in 2007 and 2010, respectively, all in electrical engineering. He is currently a Senior Member of the Technical Staff - Research with AT&T Labs Research, Bedminster, NJ, USA, and an Adjunct Assistant Professor with Columbia University, New York, NY, USA. His research interests are in the applications of statistical, algebraic and optimization techniques to wireless systems and distributed storage systems. Dr. Aggarwal received the Princeton University's Porter Ogden Jacobus Honorific Fellowship in 2009, and AT&T Vice President Excellence Award in 2013.

October 21, 2014
3:00–4:15 pm
Halligan 102
Camera Calibration and 3D Reconstruction with MATLAB
Dr. Dimitri Lisin, Mathworks, Ph.D., University of Massachusetts Amherst

Abstract:
Reconstructing the 3D structure of a scene from multiple images has many exciting applications, including robotics, security, and automotive safety. While there is an impressive body of literature explaining the theory and algorithms for camera calibration and 3D reconstruction, there has been a surprising lack of user-friendly software tools for solving these problems. Furthermore, there are many practical issues, such as how to position the cameras for calibration, which are rarely addressed in research papers. In this talk I will describe some of the theory and algorithms, as well as present "tips and tricks" for dealing with the practical issues. I will also demonstrate the latest tools for camera calibration and 3D reconstruction available in the Computer Vision System Toolbox for MATLAB™.

Bio:
Dima Lisin is a senior computer vision engineer at MathWorks, and a member of the Computer Vision System Toolbox development team. He has been working in computer vision for over 15 years, and he has been at MathWorks since 2011. Prior to joining MathWorks Dima developed computer vision algorithms for embedded smart surveillance cameras at VideoIQ, Inc. Dima holds a B.S. and an M.S. in Computer Science from Worcester Polytechnic Institute, and a Ph.D. in Computer Science from University of Massachusetts Amherst. He has published peer-reviewed papers on MRI segmentation, classifying images of plankton, image compression, and background modeling.

October 28, 2014
3:00–4:15 pm
Halligan 102
Perspectives on Phase Retrieval and Phase Diversity in Astronomy
Robert A. Gonsalves Emeritus Professor, ECE Department, Tufts University

Abstract:
We review the theory and use of phase retrieval and phase diversity in astronomy. Phase retrieval (PR) uses the image of a star to estimate T, the phase aberration introduced by the atmosphere and the telescope. Phase diversity (PD) is an extension of PR in which changes (diversities) are added to T so that both T and an extended object under observation can be estimated. In 1990, when the Hubble Space Telescope was found to have an optical flaw both PD and PR were used to help scientists determine a prescription to fix the flaw. A more recent use includes fine phasing of the test bed for the James Webb Space Telescope. Proposed uses include exo-planet imaging and sequential diversity imaging, in which sequential changes in the AO are the diversities. The major advantage of these methods is that they need no auxiliary hardware, like a guide star or a Shack-Hartmann wavefront sensor.

November 4, 2014
3:00–4:15 pm
Halligan 102
Internet of Things: Evolution and Convergence of Electrical Engineering and Computer Science
Artyom Astafurov, MSc, St. Petersburg National Research University of IT, Mechanics and Optics

Abstract:
The potential of IoT to change our world can be compared to that of the Internet, and, later, smartphones. Imagine a universe in which your home security system won't just tell you that you forgot to lock your door, it will lock it for you; vehicle emissions are monitored in real time and heart patients can check their vitals on a phone. As many of us are trying to experiment with connected devices, we find ourselves writing embedded code for microcontrollers, experimenting with electrical engineering and sensors, writing applications to control devices and visualize data, writing cloud services to store and communicate with the universe of things and apps connected to them. Electrical Engineering and Computer Science are converging to provide one knowledge platform for all of it. We'll discuss where development tools and platforms are moving to make IoT possible and how simple it became to bootstrap your IoT project with virtually one language! JavaScript (or ECMAScript for that matter...).

Bio:
Artyom Astafurov, engineer and entrepreneur, is a Managing Partner at DataArt, a custom software development company, where he is in charge of the Internet of Things initiatives. He is also a Co-Founder of DeviceHive, open-source platform for connected devices. Artyom holds a MSc degree in Computer Science and has over a decade of engineering and software development experience. He is interested in any combination of hardware and software that flies, connects, controls, or makes our lives better.

November 18, 2014
3:00–4:15 pm
Halligan 102
Ultimate Performance Limits of Graphene-based Tribology and Nanotube-based Electronic Technologies
Masa Ishigami, Ph.D., University of Central Florida

Abstract:
Nanoscale materials are sensitively influenced by atomic scale defects and adsorbates. Such sensitivities can be used to impart various functionalities to develop new device technologies, but they also introduce a large uncontrollable variability, which masks the intrinsic properties. Such variability has hindered advances of nanoscale science and technology. We are able to control experiments down to atomic scale and determine intrinsic properties of nanoscale materials. Such capability is important for determining the ultimate performance limits. I will show the application of our unique approach to two otherwise unsolvable problems in graphene and nanotube science and technology.

The first problem is on nanoscale friction, important for nanoscale electromechanical systems (NEMS). Interestingly, it is considered to be impossible to measure nanoscale friction at technologically relevant speeds. By using a new, sensitive technique, we measured friction of gold nanocrystals on graphene. Our result represents the first quantitative measurement of the frictional forces on nanoparticles at realistic speeds and paves way for new, bottomup nanoscale tribological technologies based on graphene. The second problem is on the impurity scattering mechanism in nanotubes. Nanotubes are considered to be useful as transducers in nanoscale sensors. Yet, resistance induced by adsorbed impurities is expected to depend strongly on the atomic structure of nanotubes, adding another source of variability detrimental to applications. We are able to perform transport measurements on nanotubes with known atomic structure and determine resistance added by a single atom. Our result defines the ultimate performance limit of nanotube-based sensor technologies.

November 25, 2014
3:00–4:15 pm
Halligan 102
Next-generation photovoltaics utilizing unconventional semiconductors for low-cost, large-scale electricity generation from the sun
Alexi C. Arango, Ph.D., MIT

Abstract:
Analysts predict that within two years electricity generated from photovoltaics will cost less than grid electricity, making it the cleanest, cheapest, and most abundant form of energy generation. The rise of solar energy, however, could fail to materialize if current photovoltaic technologies cannot meet the staggering manufacturing volumes needed to satisfy demand. Next-generation photovoltaics fabricated from unconventional semiconductors—such as organic molecular solids, conjugated polymers and inorganic semiconducting nanocrystals—promise to solve existing manufacturing bottlenecks due to their superior processing advantages, low cost and earth abundance. Unfortunately, power conversion efficiencies are currently too low for terrestrial energy applications. How can the efficiency be increased beyond the present limits? The most uncompromising hurdle is the open-circuit voltage, often well below the theoretical limit for even the best device architectures. We are exploring new device architectures employing cascade energy alignment, a new thin-film deposition technique employing low-damage sputtering, and a new measurement

technique employing electromodulation spectroscopy to build an understanding of the limits to open-circuit voltage and, ultimately, break this important barrier to higher efficiency.

December 2, 2014
No Seminar (Open Date)

December 9, 2014
3:00–4:15 pm
Halligan 102
Novel Materials and Nanostructures for Photovoltaic Energy Conversion
Seth Hubbard, Ph.D., Rochester Institute of Technology

Abstract:
This talk will give an overview of PV research at RIT, a discussion of the nanomaterials approach and specific results using quantum dot (QD) superlattices as well as InAlAsSb materials development. During the talk, we will show the effects of QD solar cell design on both absorption and open circuit voltage and discuss the nature of carrier escape and recombination paths inherent to QD solar cells. We will suggest strategies to enhance both optical escape and overall absorption from QD solar cells using both new materials systems and novel device designs. As well, we will discuss the growth and processing of a 1.7 eV InAlAsSb alloy for photovoltaic applications.