University of Southern California
Viterbi School of Engineering

Ming Hsieh Department of Electrical Engineering

2011 Research Book

First Annual Electrical Engineering Research Festival
sponsored by the Ming Hsieh Institute
April 29, 2011

ming hsieh institute
USC Viterbi School of Engineering
ELECTRICAL ENGINEERING

http://mhi.usc.edu

WELCOME FROM THE MING HSIEH INSTITUTE DIRECTOR

April 29, 2011

On behalf of the Ming Hsieh Institute (MHI), my co-directors, Hossein Hashemi, Bhaskar Krishnamachari and I are pleased to welcome you to review the outstanding research of our Ph.D. students and postdoctoral scholars in the Ming Hsieh Department of Electrical Engineering.

The Ming Hsieh Institute in the Ming Hsieh Department of Electrical Engineering was launched in July 2010, after a generous endowment gift of $35 million dollars from Mr. Ming Hsieh, an alumnus of the department. One of the main goals of the institute is to position the Electrical Engineering Department at the forefront in thought leadership in the world in the area of electrical engineering, and specifically in the development of intelligent technologies to empower mankind.

The vision for our Institute is to create a vibrant intellectual environment at USC where world-class researches in Electrical Engineering and related fields can come together and engage in the development of new ideas. The first annual Electrical Engineering Research Festival that we are hosting today is a step in this direction. We hope you enjoy your day and have great conversations with our students and faculty regarding their research.

To learn more about the Ming Hsieh Institute and its future events, please visit us at http://mhi.usc.edu.

We thank you for your participation today, and hope for your continued engagement and participation in the institute's activities.
Sincerely,

Shrikanth S. (Shri) Narayanan
Andrew Viterbi Professor of Engineering;
Professor of Electrical Engineering, Computer Science, Linguistics and Psychology

MESSAGE FROM THE MING HSIEH ELECTRICAL ENGINEERING DEPARTMENT CHAIRS


Welcome to the Ming Hsieh Department of Electrical Engineering!

USC began teaching electrical engineering more than a century ago, when the field was widely considered a subset of physics. Today our work is vitally important and critical to the advancement of the information age. As our department charges into its second century of excellence, we are defining the forefront of research in a number of important areas. These include: circuits; antennas; wireless communications; bio-signal processing; computer architecture; very large-scale integration and computer-aided design; computer networks; control systems; high-speed switching architectures; signal, image and multimedia processing; nanotechnology; optical communications; photonics; and quantum information processing.

Among our distinguished faculty are the visionary leaders of the university, including USC President Max Nikias and President Emeritus Steven Sample. We are also proud that Qualcomm and Linkabit co-founder Andrew J. Viterbi is a faculty member. In 2008, he received the National Medal of Science and was a Laureate of the Millenium Technology Prize Foundation of Finland, and in 2010, he received the IEEE Medal of Honor. The School of Engineering school bears his name. Our department is also home to thirteen other National Academy of Engineering members.

We're proud of our department's distinguished history and our vital and innovative faculty and Ph.D. students. Please take a few minutes to explore some of the highlights of their work, compiled in this Research Book.

Alexander A. Sawchuk
Leonard M. Silverman Chair
Professor andChair of
Electrical Engineering-Systems

Eun Sok Kim
Professor and Chair of
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Keith M. Chugg
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Student pages: 35

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Student pages: 84, 94, 125, 150

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Student pages: 36, 38

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Student pages: 21, 22

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Student pages: 175, 182

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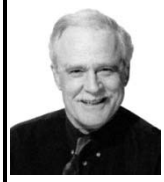
Student pages: 68, 69, 70, 71, 73, 74, 75, 77



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Student pages: 61

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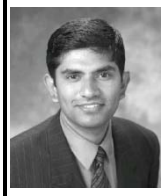
Student pages: 31



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Analysis and design of wireless ad-hoc and sensor networks.
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Professor; Ph.D., University of Newcastle, 1984. Biomedical signal and image processing methods for anatomical and functional imaging with applications in neuroimaging, oncology, and gene expression.
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Student pages: 130, 132, 137, 151, 160, 166, 172

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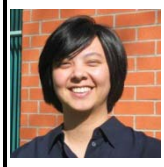
Student pages: 157



Ellis Meng
Associate Professor of Biomedical Engineering; Assistant Professor of Electrical Engineering; Ph.D., California Institute of Technology, 2004. BioMEMS, microfluidics, lab-on-a-chip, microsystem integration and packaging, world-to-chip interfacing, cell-to-chip interfacing, implantable biomedical microdevices.
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Student pages: 29, 30, 40, 42

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Student pages: 147

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Student pages: 121

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Student pages: 24, 159, 165, 180

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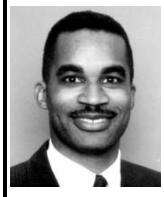
Student pages: 174, 177, 178, 179, 183



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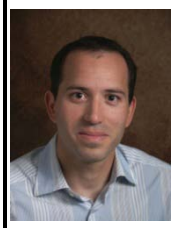

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Associate Professor; Ph.D., Stanford University, 2002. Modelling, design, and performance analysis of computer networks, sensor and mobile systems, and the web. Design of methods and algorithms to solve problems related to such systems.
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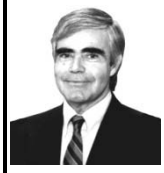

Aristides Requicha
Professor of Computer Science and Electrical Engineering; Ph.D., U. of Rochester, 1970. Nanorobotics and sensor/actuator networks.
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Student pages: 62

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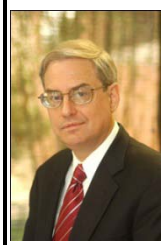

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Student pages: 136

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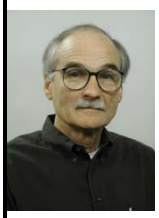

William H. Steier
William M. Hogue Professor; Ph.D., U. of Illinois, Urbana-Champaign, 1960. Nonlinear optics photonics organic polymer materials and devices for photonics nonlinear optical wave mixing in semiconductor amplifiers.
SSC 502, (213) 740-4415, steier@usc.edu
Student pages: 120, 124

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RTH 405, (213) 740-0218, gaurav@usc.edu
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Student pages: 113

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Presidential Chair Professor; Ph.D., University of Southern California, 1962.

Alan E. Willner
Professor; Ph.D., Columbia, 1988. High-speed optical fiber communication systems, with emphasis on optical amplification and wavelength-division-multiplexed technologies and networks.
EEB 538, (213) 740-4664, willner@usc.edu
Student pages: 126, 127

Zhen Zhang
Professor; Ph.D., Cornell, 1984. Information theory, coding theory, data compression and their applications.
EEB 508, (213) 740-4674, zzhang@csi.usc.edu

Chongwu Zhou
Professor; Ph.D., Yale University, 1999. Nanotechnology, nanoelectronics, and bionanotechnology; synthesis and applications of carbon nanotubes and nanowires; solar energy conversion; MEMS and bioMEMs.
RTH 511, (213) 740-4708, chongwuz@usc.edu
Student pages: 79, 81, 82, 86, 87, 91, 93, 95, 96, 129

Research Summaries

Applied Electromagnetics

Name: Jason M. Sanders

Email: jmsander@ucs.edu

Website: pulsedpower.usc.edu

Advisor: Martin Gundersen

PhD Start Date: Fall 2007

Estimated Graduation: Summer 2011

Research Title: Enabling Pulsed Power Technologies for the Generation of Intense, Nanosecond Electric Fields

Research Summary:

Jason is principally focused on the design and implementation of high voltage, high current pulse generators that are used in application areas such as ignition and combustion, biomedical, and agriculture. Circuit architectures depend on a number of parameters including pulse energy, average output power, output amplitude, pulse width, repetition rate, and load impedance. A major focus has been to miniaturize pulsed power systems that are capable of producing pulses with amplitudes between 1 and 100 kV and pulse widths between 5 and 100 ns. Characterization and modeling of complex load impedances, such as biological samples and various plasma devices, is also a focus area because knowledge of impedance as a function of frequency and applied electric field is important for system design. Miniaturization primarily occurs by synthesizing new and simpler circuits for driving opening switches, by optimizing magnetic compression stages, and by optimizing circuit layout. Recent work has focused on utilizing nonlinear materials to sharpen pulse rise-times from 10 nanoseconds to below 1 nanosecond. These fast rising, high voltage pulses are coupled onto dispersive, nonlinear transmission structures to excite solitons that can in turn be coupled of the line as bursts of RF energy.

Reference:

J. M. Sanders, A. Kuthi, and M. A. Gundersen, "Optimization and Implementation of a Solid State High Voltage Pulse Generator that Produces Fast Rising Nanosecond Pulses," Dielectrics and Electrical Insulation, IEEE Transactions on, In Press.

Name: Esin B. Sozer

Email: sozer@usc.edu

Website: pulsedpower.usc.edu

Advisor: Chunqi Jiang/ Martin A. Gundersen

PhD Start Date: Spring 2008

Estimated Graduation: Fall 2011

Research Title: Photocathodes for Back-Lighted Thyratrons

Research Summary:

High power switches are the enabling technology for very fast (nanoseconds), very high power (≈GW), compact pulsed power systems. Applications of pulsed power technology include medicine, pollution control, energy and aerospace, many of which require reliable yet compact system components suitable for portable systems. The back-lighted thyratron (BLT) is an optically triggered high power plasma switch. Mini-BLTs developed by the USC pulsed power group are 20 times smaller in volume than a traditional commercial switch with comparable voltage and current rating with reasonable lifetime (>10^8 shots). My research is particularly focused on implementation of novel photocathodes to BLT. Our measurements of quantum efficiency of magnesium, copper and molybdenum photocathodes under BLT-relevant gas and pressure conditions showed that Mg is a promising candidate as a BLT cathode material. Moreover, our recent experiments on a BLT with a Mg-based photocathode showed that the delay of the switch is reduced three times when Mg is present at its cathode. We are continuing to conduct experiments aiming to understand the underlying physics of electron emission mechanisms involved in switching, and to investigate alternative light sources for triggering BLTs.

Reference:

E. B. Sozer, et al., “Quantum efficiency measurements of photocathode candidates for back-lighted thyratrons”, IEEE Transactions on Dielectrics and Electrical Insulation, vol.16, no.4, pp.993-998, (2009)

Bio-Electronics & Bio-Optics

Name: Ben P. McIntosh

Email: ben.mcintosh@usc.edu

Website: omdl.usc.edu

Advisor: Armand R. Tanguay, Jr.

PhD Start Date: Fall 2007

Estimated Graduation: Fall 2012

Research Title: Ultraminiature Imaging Systems for Retinal Prostheses, and the Visual Psychophysics of Foveation for RP and AMD

Research Summary: Both Retinitis Pigmentosa (RP) and Age-Related Macular Degeneration (AMD) cause a loss of light perception that results from degeneration of the photoreceptors within the outer layer of the retina and render millions blind each year. However, retinal ganglion cells within the inner layer of the retina are still viable and can respond to electrical stimulation via microelectrodes as part of a retinal prosthesis. The prosthesis is typically driven by a camera that can be either external to the eye (extraocular) or internal to the eye (intraocular). These two approaches have implications on the optical system design requirements including resolution, field-of-view, and methods by which images from the camera are processed in preparation for microelectrode stimulation.

My research has focused primarily on (1) gaining a better understanding of fundamental imaging requirements for prosthetic vision, (2) the design of new generations of ultra-miniature optical systems to be used for intraocular and eye-tracked extraocular cameras, and (3) enhancing existing extraocular retinal prostheses by adding foveation ability. To this end, a visual prosthesis simulator has been developed to studying the effects and value of adding foveation by allowing sighted subjects to perform tasks using simulated prosthetic vision under AMD and RP conditions.

Reference:

P. J. Nasiatka, N. R. B. Stiles, B. P. McIntosh, M. C. Hauer, J. D. Weiland, M. S. Humayun, and A. R. Tanguay, Jr., “An Intraocular Camera for Retinal Prostheses: Restoring Sight to the Blind”, Chapter 20 in *Optical Processes in Microparticles and Nanostuctures*, Advanced Series in Applied Physics, Volume 6, A. Serpenguzel and A. Poon, Eds., World Scientific, Singapore, (November, 2010).

Name: Furkan E. Sahin

Email: fsahin@usc.edu

Advisor: Armand R. Tanguay, Jr.

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Design of Short Focal Length, Wide-Angle Lenses for Miniature Cameras

Research Summary:

With the advancements in semiconductor processing technologies, pixel sizes in digital cameras have scaled down, leading to high-resolution, miniature image sensor arrays. Integrating miniature image sensor arrays with short focal length, wide-angle optics will open new paths in a variety of areas such as novel biomedical devices, distributed sensing systems and automotive technologies.

Communications

Name: Ansuman Adhikary

Email: adhikary@usc.edu

Advisor: Giuseppe Caire

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Cognitive Femtocells

Research Summary:

My work is on “cognitive” femtocells that can decode the base station control channel and make transmission decisions based on the scheduling and resource allocation of the overlaying macrocell. Under certain system assumptions, the tradeoff region between the macrocell throughput versus aggregate femtocell throughput is obtained. For the basic system architecture, the effect of open versus closed access (typical in a wireless network having femtocells) and interference cancellation at the femtocells is evaluated. In addition, a modified “downlink interference alignment” scheme, and multiple antennas at the femtocells are used for possible improvements. Finally, effects of imperfect channel state information at the femto access points are also considered. It is remarkable that a careful combination of these techniques achieves a large aggregate femtocell throughput, at a very low penalty in terms of the precious macrocell throughput.

Reference:

“Cognitive Femtocells: Breaking the Spatial Reuse Barrier of Cellular Systems”
Web link : ita.ucsd.edu/workshop/11/files/paper/paper_436.pdf

Name: Ozgun Bursalioglu Yilmaz

Email: bursalio@usc.edu

Website: www-scf.usc.edu/~bursalio/

Advisor: Giuseppe Caire

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2011

Research Title: Lossy Joint Source Channel Coding

Research Summary:

A new coding scheme for image transmission over noisy channel is proposed. Similar to standard image compression, the scheme includes a linear transform followed by embedded scalar quantization. Joint source-channel coding is implemented by optimizing the rate allocation across the source subbands, treated as the components of a parallel source model. The quantized transform coefficients are linearly mapped into channel symbols, using systematic linear encoders of appropriate rate. This fixed-to-fixed length "linear index coding" approach avoids the use of an explicit entropy coding stage, which is typically non-robust to post-decoding residual errors. Linear codes over GF(4) codes are particularly suited for this application, since they are matched to the alphabet of the quantization indices of the dead-zone embedded quantizers used in the scheme, and to the QPSK modulation used on the deep-space communication channel. Therefore, we optimize a family of systematic Raptor codes over GF(4) that are particularly suited for this application since they allow for a continuum of coding rates, in order to adapt to the quantized source entropy rate (which may differ from image to image) and to channel capacity. Comparisons are provided with respect to the concatenation of state-of-the-art image coding and channel coding schemes used by Jet Propulsion Laboratories (JPL) for the Mars Exploration Rover Mission.

Reference:

Ozgun Y. Bursalioglu, Giuseppe Caire, and Dariush Divsalar "Joint Source-Channel Coding for Deep Space Image Transmission using Rateless codes,"Information Theory and Applications Workshop (ITA – 11), San Diego, CA, February 2011.

Name: Sunav Choudhary

Email: sunavcho@usc.edu

Advisor: Urbashi Mitra

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2015

Research Summary:

Due to a wide range of applications, including sonar, underwater navigation, target localization and marine environment monitoring, study and characterization of the underwater acoustic channel has become extremely important in recent years. The underwater acoustic channel has been described as possibly being “nature's most unforgiving wireless medium”, which stems from the property of the channel being doubly dispersive (i.e. in both time and frequency domains). Sunav Choudhary's research presently focuses on reliable estimation of this channel which is fundamental to the design of all underwater acoustic communication receivers. To this end, he utilizes the inherent sparsity in the underwater acoustic channel to obtain better estimates using sparse approximation techniques. Beside giving a better estimate, sparse approximation also leads to less computational overhead for channel estimation when compared to conventional methods.

Name: Chiranjib Choudhuri

Email: cchoudhu@usc.edu

Advisor: Urbashi Mitra

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: On the Fundamental Limits of Communication for Simple Multi-terminal Networks

Research Summary:

From as early as 1948, with Shannon's seminal work on "A Mathematical Theory of Communication" laying out the foundation for information theory, finding the fundamental limits, known as *capacity*, of a general communication network, became the holy grail of communication theory. And with the data rate pushing the limits, near capacity achieving coding strategies are the needs of the hour. These questions are at the heart of network information theory, yet complete answers remain elusive for the past 60 years. Chiranjib Choudhuri's research addresses both of these issues for a few multi-terminal channel models, which are the main building blocks of a more complicated communication network. He looked at the problem of joint communication and channel estimation from information theoretic perspective, where the receiver not only wants to decode a message communicated to it by the transmitter, but also interested in estimating the unknown environment in which the communication is taking place. The transmitter having some prior knowledge of the environment has to divide it's resources between encoding the message and the environment to help reveal both to the receiver. To prove the results, we need to extend the well-known data processing inequality of information theory to the regime of estimation theory. Just like the data processing inequality of information theory, this type of data processing inequality for estimation theory will be an integral step for proving any optimality results in the domain of joint communication and estimation. Additionally, the tools used in proving the results are found to be very helpful in better understanding some of the long standing and well-known open problems in distributed control and information theory. Parts of this work are published in many conferences and the full version is communicated to IEEE Transactions on Information Theory for possible publication.

Reference:

C. Choudhuri, Y.-H. Kim and Urbashi Mitra, "Capacity-distortion trade-off in channels with state", Allerton Conference, Monticellon IL, Oct. 2010.

Name: Hassan Ghozlan

Email: ghozlan@usc.edu

Advisor: Gerhard Kramer

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Interference Models for Fiber-Optic Networks

Research Summary:

The majority of infrastructure of communication networks are optical fiber. The exponential increase in demand for higher data rates, and the emergence of bandwidth-hungry applications motivated the advent of optical communication technology. However, the view of optical fiber as a medium that provides “bandwidth to burn” is coming to an end. Thus the key to achieving higher data rates is designing more efficient communication schemes rather than using more bandwidth. Ghozlan's research involves using information theoretic tools to study the ultimate limit of reliable communication, called “capacity”, using the wave-division multiplexing technology in fiber optic networks.

Reference:

"Interference focusing for mitigating cross-phase modulation in a simplified optical fiber model," H. Ghozlan and G. Kramer, IEEE Int. Symp. Inf. Theory, Austin, TX, pp. 2033-2037, June 13-18, 2010.

Name: Hoon Huh

Email: hhuh@usc.edu

Advisor: Giuseppe Caire

PhD Start Date: Fall 2006

Estimated Graduation: Summer 2011

Research Title: Large System Analysis of Multi-cell MIMO Downlink: Fairness Scheduling and Inter-cell Cooperation

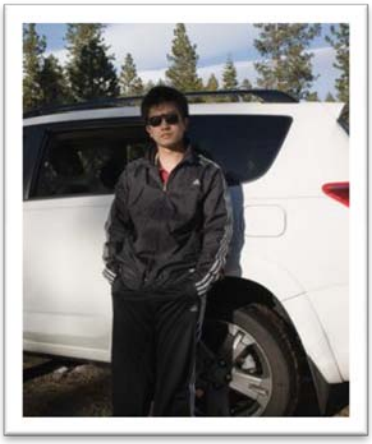
Research Summary:

Multiuser MIMO (MU-MIMO) technology is expected to play a key role in the future wireless cellular networks. In order to appreciate its full potential in a cellular scenario, we need to consider a multi-cell coverage with realistic pathloss, fairness scheduling, inter-cell cooperation, and the type of precoding and channel state information available at the transmitter (CSIT). However, taking into account all these aspects is very complicated and the analytical characterization is generally very difficult and, so far, its performance has been evaluated by Monte Carlo simulations. In this work, we propose an alternative approach based on the "large-system limit." We leverage results on large random matrices and analyze asymptotically the system achievable rate in the limit where both the number of antennas per base station (BS) and the number of users per cell grow to infinity with a fixed ratio. Using these results, we consider important system design problems: 1) optimize the inter-cell cooperation cluster size, 2) design a random scheduling algorithm that requires much less CSIT feedback, 3) evaluate the performance of the so-called "massive MIMO" and consider the scheduling algorithm based on the users' relative locations to the BSs.

Reference:

H. Huh, A. M. Tulino, and G. Caire, "Network MIMO with linear zero-forcing beamforming: large system analysis, impact of channel estimation and reduced-complexity scheduling," submitted to IEEE Trans. on Inform. Theory, 2010. [Online]. Available: http://arxiv.org/abs/1012.3198

Name: Mingyue Ji



Email: mingyuej@usc.edu

Website: http://www-scf.usc.edu/~mingyuej/

Advisor: Giuseppe Caire

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2014

Research Title: Information Theory

Research Summary:

I am interested in information theory and signal processing with applications in wireless communications. Especially, I focus on what are the fundamental limits such as capacity, degree of freedom, of a wireless network, and how to design the physical layer transmissions for the wireless communication system in the interfering environments.

Name: Ching-Yi Lai

Email: aiching@usc.edu

Website: http://www-scf.usc.edu/~laiching/

Advisor: Todd A. Brun

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Summary:

Quantum error-correcting codes help the implementation of quantum computations or quantum communications. It is known that entanglement increases the rate or the error-correcting ability of quantum codes. Ching-Yi Lai's research area includes quantum error-correcting codes and quantum information processing. He found the MacWilliams identities and linear programming bounds for entanglement-assisted quantum codes and examined the existence and non-existence of entanglement-assisted quantum codes. He also proposed two constructions of entanglement-assisted quantum codes and obtained several optimal code parameters. Currently He is working on entanglement-assisted quantum codes with entanglement distillation and fault-tolerant quantum computation.

Reference:

Ching-Yi Lai, Todd A. Brun, and Mark M. Wilde, ``Dualities and Identities for Entanglement-Assisted Quantum Codes,''submitted to IEEE Transaction on Information Theory, December, 2010. [Online] Available: http://arxiv.org/abs/1010.5506.

Name: David K. Lee

Email: David.K.Lee@gdc4s.com

Advisor: Keith M. Chugg

PhD Start Date: Fall 2004

Estimated Graduation: Fall 2012

Research Title: Pragmatic Approach to Cooperative Communications and Dual-Polarization Frequency Reuse

Research Summary:

The unifying goal of any realizable communication system is maximizing system capacity within its given resource constraints. Two such communication techniques (1) *cooperative communications*, and (2) *dual-polarization frequency reuse* (DPFR), offer effective methods to increase system capacity. The cooperative communication paradigm potentially increases transmission *reliability* using diversity; while dual-polarization frequency reuse increases transmission *rate* via multiplexing. Both communication techniques are plagued by their unique, ideal implementation challenges. Realizing the objectives of increasing transmission *reliability* and *rate* conveniently dovetail into the two broad categories of MIMO (multiple-input multiple-output) transceiver design, both cooperative communications and DPFR naturally are potential benefactors of MIMO analysis. By applying MIMO techniques in conjunction with modern error correction coding to each of these applications, we introduce a more pragmatic and implementable approach for these two respective communication techniques. Modulation constrained information rate analysis together with simulation show that performance is comparable to the respective, ideal system.

Reference:

D. K. Lee and K. M. Chugg, "Pragmatic cooperative diversity communications," in *Proc. IEEE Military Comm. Conf.*, Washington D.C., pp. 1272-78, Oct. 2006.

Name: Dimitris S. Papailiopoulos

Email: papailio@usc.edu

Website: http://www-scf.usc.edu/~papailio/home.html

Advisor: Alex Dimakis

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2013

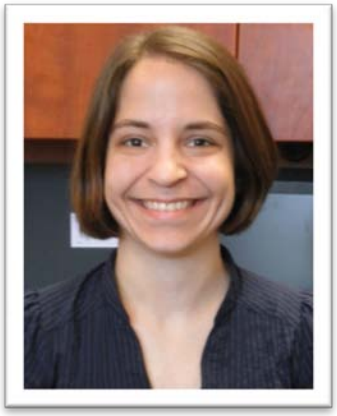
Research Title: Rate maximization techniques for Interference Channels and erasure resilient Distributed Storage Networks.

Research Summary:

Over the past years, Dimitris has been working on problems at the intersection of Communication theory, Information theory, Optimization, and Algorithms. He is particularly interested in problems of Distributed Storage, Interference Channels, Sparse Signal Representations, Combinatorial Optimization, and Convex Approximations. His research work can be split into three major topics: i) Coding for Distributed Storage, ii) Signal Design for Interference Channels, and iii) Combinatorial Optimization for Signal Analysis. Although these topics might seem different, he tries to use fundamental mathematical tools to exploit the structure of practical engineering problems and develop efficient solutions.

Reference:

D. S. Papailiopoulos and A. G. Dimakis, "Interference Alignment as a Rank Constrained Rank Minimization," IEEE GLOBECOM, Miami, FL, Dec. 2010.



Name: Kristen Pudenz

Email: pudenz@usc.edu

Website: http://qserver.usc.edu/group/

Advisor: Daniel Lidar

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Verification and Validation via Quantum Learning and Testing

Research Summary:

Kristen Pudenz's research attacks the exponentially difficult problem of verification of classical software using a novel quantum approach, based on training and using a classifier whose job it is to identify software bugs. Such an approach has two complementary quantum aspects. The first is to formulate the training problem as a quantum one. The second is to apply the trained classifier in quantum-parallel on the space of all paired input and output vectors which may be generated by the software under test. Ms. Pudenz has developed a practical algorithm for attacking both problems with limited available qubits and simulated results of selected problems for the proposed algorithm.

Name: Karthikeyan Shanmugam

Email: kshanmug@usc.edu

Advisor: Giuseppe Caire and Alex Dimakis

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2015

Research Title: Content Aware Wireless Networks

Research Summary:

In near future mobile traffic demand for video data is expected to increase dramatically.

This may overload the present day networks significantly. The present day cellular wireless networks are agnostic to redundancy that the traffic may contain. Currently I am interested in optimal transmission and resource allocation schemes that exploit data redundancy in wireless networks and their performance analysis.

Reference:

K. Shanmugam, S. Bhashyam, *"Rate Gap Analysis for Rate-adaptive Antenna Selection and Beamforming Schemes"* Proceedings of IEEE GLOBECOM 2010, Miami, FL, USA, December 2010.

Name: Junyang Shen

Email: junyangs@usc.edu

Website: http://wides.usc.edu/people/phd-students/junyang-shen/

Advisor: Andreas F. Molisch

PhD Start Date: Fall 2009

Estimated Graduation: Summer 2014

Research Title: Development of Accurate Passive Target Localization Systems

Research Summary:

Passive-object positioning is important in many practical situations like crime-prevention surveillance, assets tracking, and medical patient monitoring, where the target is a reflecting/scattering object that is unwilling/unable to carry a wireless transceiver. Junyang Shen proposes a novel passive object localization algorithm, using the Expectation Maximization and two-step maximum likelihood estimation methods. The Cramer-Rao Lower Bound (CRLB) sets the low bound of any unbiased estimation methods. The proposed method achieves the CRLB of passive target positioning algorithms when the signal travel range errors are Gaussian and small.

Reference:

J. Shen., T. Jiang, S. Liu and Z. Zhang, "Maximum Channel Throughput via Cooperative Spectrum Sensing in Cognitive Radio Networks," IEEE Transactions on Wireless Communications, vol.8, no.10, pp. 5166-5175, October 2009

Name: Srinivas Yerramalli

Email: srinivas.yerramalli@usc.edu

Website: http://www-scf.usc.edu/~yerramal

Advisor: Urbashi Mitra

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2012

Research Title: Communications over highly Doppler distorted underwater acoustic channels

Research Summary:

The design and development of underwater acoustic digital communications have received significant increase in attention over the last few years driven by applications such as environmental sensing, deep ocean oil and gas exploration, commercial fishing and coastal and harbor surveillance, command and control links to submarines and detection of underwater events such as tsunami inducing earthquakes. Underwater communications employ acoustic waves since radio waves barely propagate in the ocean and acoustic signaling presents several unique challenges for the design of high data rate systems: large propagation delays and delay spreads, compression and dilation of transmitted signals due to Doppler effect and distance dependent usable bandwidth. His research focuses on development and analysis of communication algorithms for high-speed in-water communication links to counter the challenging signaling environment. He has first developed an analysis of currently used signaling schemes on underwater acoustic channels to predict where current receivers would underperform significantly and when they could be used. Based on the analysis, he has proposed a novel receiver design exploiting signal structure induced by the Doppler distortion to provide close to an order of magnitude reduction in data detection errors. He is currently working on the application of game theory to enable co-ordination and cooperation in underwater sensor networks with an objective to achieve efficient utilization of bandwidth and improve battery life and collaborating with the robotics research group to develop abstracted communication models for facilitating coordination for teams of underwater vehicles.

Reference:

Srinivas Yerramalli and Urbashi Mitra, “Optimal Resampling of OFDM Signals for Multi-Scale Multi-Lag Underwater Acoustic Channels”, IEEE Journal of Oceanic Engineering, vol. 36, No. 1, Jan 2011.

Name: Yicong Zheng

Email: yicongzh@usc.edu

Advisor: Todd A. Brun

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2013

Research Title: Develop Scalable and High Threshold Fault-tolerated Quantum Computer

Research Summary:

Quantum computers handle the ability to solve the certain problems much faster than their classical counterpart. However, quantum computation is very vulnerable to the noise introduced by environment. So, we need to carefully design the physical system and well designed quantum error correction code fault tolerant scheme. Recently, we propose a feasible scheme to achieve quantum computation based on geometric manipulation of ensembles of atoms, and analyze it for neutral rubidium atoms magnetically trapped in planoconcave microcavities on an atom chip. The geometric operations are accomplished by optical excitation of a single atom into a Rydberg state in a constant electric field. Strong dipole-dipole interactions and incident lasers drive the dark state of the atom ensembles to undergo cyclic evolutions that realize a universal set of quantum gates. Such geometric manipulation turns out naturally to protect the qubits from the errors induced by non-uniform laser illumination as well as cavity loss. The gate performance and decoherence processes are assessed by numerical simulation.

Reference:

Yicong Zheng and Todd. A. Brun, Geometric Unitary Gates in Cold Atom Ensembles on an Atom Chip, (to be submitted).

Name: Daphney-Stavroula Zois

Email: zois@usc.edu

Website: http://www-scf.usc.edu/~zois/

Advisor: Urbashi Mitra

PhD Start Date: Fall 2008

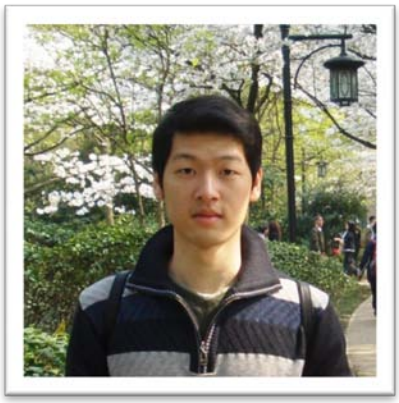
Estimated Graduation: Spring 2013

Research Title: Design and Implementation of Energy-Efficient Schemes in Wireless Body Area Networks for Activity Recognition Applications

Research Summary:

The rapid growth of physiological sensors and low power integrated circuits together with the increasing use of wireless networks has enabled the development of a new generation of wireless sensor networks known as Wireless Body Area Networks (WBANs). A WBAN usually consists of various sensors that are attached on clothing or on the body or even implanted under the skin and a fusion center, which is usually a personal device, e.g. cellphone, PDA. Such networks due to their wireless nature and distinctive capabilities of their sensors have a lot of new and innovative applications, including health, sports, lifestyle, emergency situations, military or security. However, they face a lot of significant challenges that are in effect more difficult and unique compared to the ones that traditional sensor networks encounter. In this framework, Daphney-Stavroula Zois' PhD research focuses on the design and implementation of power conservation schemes for the energy efficient detection of physical activities e.g. sitting, standing, walking performed by an individual. Specifically, it has been observed through experimentation that the continuous communication between the fusion center and the sensor nodes leads to limited network lifetime since it drains quickly the battery life of the fusion center. This observation makes imperative the design of a power saving strategy that will minimize the power consumption on the fusion center while at the same time, it will keep the correct activity detection probability within acceptable levels. Towards this direction, she has modeled the aforementioned problem using Partially Observable Markov Decision Processes (POMDPs) and at the time being, she is in the process of evaluating the optimal solutions she has determined. At the same time, she is working on devising polynomial-time approximation solutions of the same problem.

Computer Architecture



Name: Lizhong Chen

Email: lizhongc@usc.edu

Website: http://ceng.usc.edu/smart/people/lizhong.html

Advisor: Timothy Pinkston

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

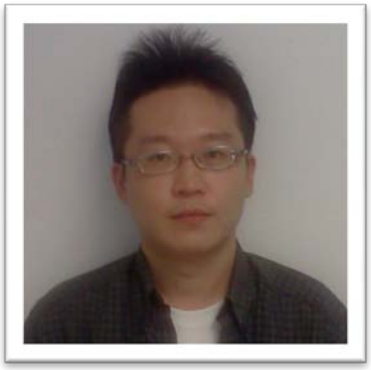
Research Title: Design of High-performance and Energy-efficient Interconnection Networks

Research Summary:

With parallel processing pervading the entire computing landscape—from server clouds built from chip multi-processors to embedded compute nodes built from systems-on-chip—the interconnection network plays an increasingly important role by providing efficient communication support among various system components. Consequently, there is a pressing demand for interconnection network to achieve high throughput, low latency and minimal power consumption. As a Ph.D. student, Lizhong Chen's research focuses on the design of high-performance and energy-efficient interconnection networks for parallel computing systems. He has been investigating energy-aware techniques that improve the performance of both interconnection networks and overall systems, including express channel, hybrid circuit- and packet-switching, and energy-proportional on-chip network designs. By noticing the inefficiencies in resource utilization of Bubble Flow Control (e.g., used in IBM Blue Gene/L), he has developed a new globally-aware flow control mechanisms, called Critical Bubble Scheme, which reduces the minimum buffer requirements for avoiding deadlock by 50%, while increasing throughput by 11%. In addition, he also has strong interest in providing on-chip network support for holistic many-core design, which requires processor-cache-interconnect co-optimization.

Reference:

Lizhong Chen, Ruisheng Wang and Timothy M. Pinkston, *"Critical Bubble Scheme: An Efficient Implementation of Globally-aware Network Flow Control"*, in Proceedings of the 25th IEEE International Parallel & Distributed Processing Symposium (IPDPS), Anchorage, Alaska, USA, May 2011.



Name: Woojin Choi

Email: woojinch@usc.edu

Advisor: Jeff Draper

PhD Start Date: Fall 2004

Estimated Graduation: Fall 2011

Research Title: Design Space Exploration for Conflict Detection in Transactional Memory Systems

Research Summary:

Transactional Memory (TM) promises to increase programmer productivity by making it easier to write correct parallel programs. In fulfilling this goal, a TM system should maximize its performance with limited hardware resources. Conflict detection is an essential element for maintaining correctness among concurrent transactions in a TM system. Hardware signatures have been proposed as an area-efficient method for detecting conflicts. However, signatures can degrade TM performance by falsely declaring conflicts (false positives). Hence, increasing the accuracy of signatures within a given hardware budget is a crucial issue for TM to be adopted as a mainstream programming model.

Woojin Choi's Ph.D. research has focused on developing effective hardware signatures for TM systems. Observing that some false positives can be helpful to TM performance by triggering the early abortion of a transaction which would encounter a true conflict later anyway, he introduced adaptive-grain signatures to improve TM performance by dynamically changing the range of address keys based on the history. Adaptive-grain signatures can increase the number of performance-friendly false positives as well as decrease the number of performance-destructive false positives.

Reference:

Woojin Choi and Jeff Draper, "Unified Signatures for Improving Performance in Transactional Memory," in Proceedings of the 25th International Parallel and Distributed Processing Symposium (IPDPS), 2011.

Name: Lakshmi Kumar Dabbiru

Email: dabbiru@usc.edu

Website: http://www-scf.usc.edu/~dabbiru/

Advisor: Murali Annavaram

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Reducing the cost of computing

Research Summary:

Computing is part of our lives and to continue it "cost of computing" must be low even though the requirements and complexity of computing increases. Cost includes energy consumed by the devices, ease of manufacturing, software effort by humans and etc. To address this, innovations are needed in the entire computing stack and the way we do the computing itself. As single core is no longer energy efficient, the future architectures might be drastically be different from existing architectures.

Multicores are prevalent now and currently my work focuses on improving various issues with them. Evaluated methods to improve the tradeoff between speedup and accuracy of parallel simulation of CMPs in SlackSim, a home grown parallel simulation framework. My current work aims to further improve the parallel simulation performance and even adapt it to other scenarios like heterogeneous architectures. I am also working on quantitative methods to better understand the transactional memory's performance on multicores. I am also looking forward in tackling the issues in architecture and systems for cloud and mobile computing.

Reference:

"Adaptive and Speculative simulation of CMPs on CMPs", Jianwei Chen, Dabbiru Lakshmi Kumar, Daniel Wong, Murali Annavaram and Michel Dubois. In Proceedings of the 2010 International symposium on Microarchitecture(MICRO), Dec 2010.

Name: Sang Wook Stephen Do

Email: sdo@usc.edu

Advisor: Michael Dubois

PhD Start Date: Spring 2008

Estimated Graduation: TBD

Research Title: Lock-free synchronization for multiprocessor systems

Research Summary: Since the main stream of microprocessor architecture moved from developing high performance uniprocessor systems to systems composed of many simple processor cores sharing resources, one of the most important challenges in designing such kind of multi-core systems as well as other conventional multi-processor systems using different configurations has been synchronizing independent processor cores appropriately to fulfill given parallel tasks efficiently. Even, it is getting harder to meet this challenge because the synchronization overhead increases as the number of processor cores increases in modern high performance systems. The purpose of this research is to develop an efficient synchronization mechanism based on a lock-free or optimistic approach similar to that used in Transactional Memory systems.

Name: Waleed “Mohammad Khaled” Dweik

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Website: http://www-scf.usc.edu/~dweik/

Advisor: Murali Annavaram

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: Software Directed Fault Handling

Research Summary:

As technology feature size scales down into the nanometer regime, device reliability emerges as a first order design constraint. Despite the expected high performance and cost advantages achieved by having billions of transistors on chip, those transistors are becoming more susceptible to different types of faults. Waleed Dweik Ph. D. research focuses on developing software mechanisms to handle transient, intermittent and permanent faults. He is working on a new class of exceptions called Reliability Aware Exceptions (RAE). RAE is a software mechanism with minimal hardware cost which provides the ability to classify the cause of a fault to one of the three categories. Fault detection is done in hardware and once a fault is detected the hardware raises an exception. Exceptions are handled by software where classification and the resulting fault handling algorithms run as specialized exception handling routines. The exception handlers are equipped with the ability to manipulate micro-architectural blocks to recover from all three categories. Waleed has successfully implemented RAE to protect two major storage structures: reorder buffer (ROB) and load/store queue (LSQ), ran simulation experiments on 10 SPEC2000 benchmarks. He is preparing to submit his work on RAE to the 44th Annual IEEE/ACM International Symposium on Microarchitecture.

Reference:

B. Zandian, W. Dweik, S. Kang, T. Punihaole, M. Annavaram. Continuous Reliability Monitoring Using Adaptive Critical Path Testing. In Proceedings of the 2010 Dependable Systems and Networks (DSN), pages 151-160, June 2010

Name: Mahta Haghi

Email: mhaghi@usc.edu

Advisor: Jeff Draper

PhD Start Date: Spring 2005

Estimated Graduation: Spring 2012

Research Title: Modeling and Mitigation of Radiation-Induced Charge Sharing Effects in Advanced Electronics

Research Summary:

This research proposes the investigation of single event upset sensitivity of MOS Current Mode Logic (MCML) sequential elements, and suggests a Radiation Hardening by Design (RHBD) method to mitigate Single Event Upsets for MCML latches and flip-flops. We also suggest layout and process techniques for charge sharing and collection reduction among adjacent devices to decrease multiple bit upsets. These techniques can be applied to both CMOS and MCML structures. Furthermore, we propose to develop a model that can be used in circuit simulators, like HSPICE, to predict the effect of charge sharing among adjacent devices due to a single ion strike. This model can be employed in circuit simulators in early stages of a design without the need to run uncommon, long and slow device simulations or costly physical laser tests after fabrication. Finally, we will also initiate an investigation on the radiation effects and mechanisms on electronics in aligned carbon nanotube technology, one of the most promising post-silicon technologies, by using 3D-TCAD simulations.

Reference:

M. Haghi, J. Draper. “The Effect of Design Parameters on Single-Event Upset Sensitivity of

MOS Current Mode Logic”, GLSVLSI, Proceeding, pp.233-238, May 2009

Name: Young Hoon Kang

Email: youngkan@usc.edu

Advisor: Jeff Draper

PhD Start Date: Fall 2004

Estimated Graduation: Summer 2011

Research Title: Fault-Tolerant Flow Control in On-Chip Networks

Research Summary:

Scaling of interconnects exacerbates the already challenging reliability of on-chip networks. Although many researchers have provided various fault handling techniques in chip multi-processors (CMPs), the fault-tolerance of the interconnection network is yet to adequately evolve. As an end- to-end recovery approach delays fault detection and complicates recovery to a consistent global state in such a system, a link-level retransmission is endorsed for recovery, making a higher-level protocol simple. In this paper, we introduce a fault-tolerant flow control scheme for soft error handling in on-chip networks. The fault-tolerant flow control recovers errors at a link-level by requesting retransmission and ensures an error-free transmission on a flit-basis with incorporation of dynamic packet fragmentation. Dynamic packet fragmentation is adopted as a part of fault-tolerant flow control to disengage flits from the fault-containment and recover the faulty flit transmission. Thus, the proposed router provides a high level of dependability at the link-level for both datapath and control planes. In simulation with injected faults, the proposed router is observed to perform well, gracefully degrading while exhibiting 97% error coverage in datapath elements. The proposed router has been implemented using a TSMC 45nm standard cell library. As compared to a router which employs triple modular redundancy (TMR) in datapath elements, the proposed router takes 58% less area and consumes 40% less energy per packet on average.

Reference:

Young Hoon Kang, Taek-Jun Kwon, and Jeff Draper, Fault-Tolerant Flow Control in On-Chip Networks, In Proceedings of the 4th International Symposium on Networks-on-Chip, May 2010

Name: Fatemeh Kashfi

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Website: http://atrak.usc.edu/~fatemeh/

Advisor: Jeff Draper

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: 3D ICs

Research Summary:

In electronics, a three-dimensional integrated circuit is a chip in which two or more layers of active electronic components are integrated both vertically and horizontally into a single circuit. The semiconductor industry is hotly pursuing this promising technology in many different forms, but it is not yet widely used. In my research I will design and analyze different 3D micro-architectures with focus on energy and power of them.

Name: Jinho Suh

Email: jinhosuh@usc.edu

Advisor: Michel Dubois

PhD Start Date: Fall 2004

Estimated Graduation: Fall 2011

Research Title: Architectural Soft Error Reliability of Caches: Modeling and Simulations

Research Summary:

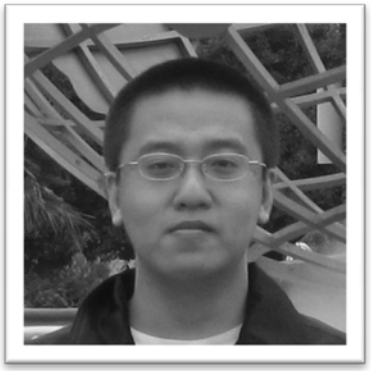
Caches today occupy 50% of chip estate. The charge stored in a static random-access memory cell is reducing with every process generation, making caches susceptible to single event upsets resulting in soft errors.

Without an accurate measure of how soft errors can affect system reliability, designers rely on either worst case assumptions or at best approximations to decide on the level of soft error protection. Since estimates may either over-provision the protection hardware or compromise system reliability, accurately measuring the resilience of a system to soft errors is critical. Because soft errors happen randomly and very rarely, measuring the soft error reliability becomes challenging; obtaining the proper measurement data from field is both hard and limited in number, and performing artificial tests typically lead distortions in measurements. Analytical model thus becomes excessively important to estimate the soft error vulnerability on the target systems with simulations.

Measuring soft error reliability on target systems requires solving two important, hard problems: (1) having a rigorous analytical model, and (2) making simulations efficient enough to finish in a reasonable amount of time using an affordable amount of resources. His research provides the solution to the above problems.

Reference:

J. Suh, M. Manoochehri, M. Annavaram and M. Dubois. Soft Error Benchmarking for L2 Cache with PARMA. In Proceedings of the ACM SIGMETRICS International Conference on Measurement and Modeling of Computer Systems, June 2011.



Name: Ruisheng Wang

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Website: http://www-scf.usc.edu/~ruishenw

Advisor: Timothy Mark Pinkston

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Thread criticality support in on-chip networks; Architectural support for server consolidation in CMP

Research Summary:

Multicore computing is becoming the mainstream approach in computer system designs to effectively use growing transistor budgets for harnessing performance and energy-efficiency. Increasing the parallelism with more cores requires careful management, allocation, or partitioning of shared resources to cope with varying resource demands from running program threads. Predicting critical (i.e., slowest) threads and accelerating execution of those threads can reduce execution time of parallel applications by balancing the execution of threads to synchronization points. The on-chip network is an increasingly important component that services communication of threads running on cores. As the communication latency of threads affects thread criticality, it should be considered and optimized. In an effort led by Yuho Jin, a postdoc in the group, Ruisheng Wang helped to evaluate a flow control technique designed to reserve router resources in order to accelerate communication from critical threads. Criticality-aware on-chip network designs enable benefits in power reduction and system throughput. Ruisheng Wang plans to focus his research on architectural support for server consolidation. He is developing holistic, feedback-based on-chip resource management mechanisms designed to provide fairness in datacenter-on-chip environments. Ruisheng Wang's previous work lies in area of High Performance Router design, including Switch Architecture, Packet Scheduler and IP Lookup. He has published three papers in this area.

Reference:

Yuho Jin, Ruisheng Wang, Woojin Choi, Timothy Mark Pinkston, “Thread Criticality Support in On-Chip Networks,” In Proceedings of the Third International Workshop on Network on Chip Architectures (NoCArc 2010), held in conjunction with the 43rd Annual IEEE/ACM International Symposium on Microarchitecture (MICRO-43)

Name: Daniel Wong

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Website: http://scf.usc.edu/~wongdani/

Advisor: Murali Annavaram

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Energy Efficient Scheduling and Checkpoint Mechanisms for Exascale Computing

Research Summary:

As we approach the exascale era of computing, many challenges must be met. My research focuses on two aspects of exascale computing challenges including energy efficiency and reliability though energy efficient scheduling policies and checkpoint mechanisms for large-scale distributed systems. In addition, I am interested in the areas of parallel microarchitecture and embedded systems.

Reference:

J. Chen, K. Dabbiru, D. Wong, M. Annavaram and M. Dubois. Adaptive and Speculative Slack Simulations of CMPs on CMPs. In *Proceedings of the 2010 International Symposium on Microarchitecture (MICRO),* Dec 2010.

Name: Yi-Hua Edward Yang

Email: yeyang@usc.edu

Website: http://www-scf.usc.edu/~yeyang/

Advisor: Viktor K. Prasanna

PhD Start Date: Spring 2008

Estimated Graduation: Summer 2011

Research Title: High Performance String and Regular Expression Matching on Parallel Architectures

Research Summary:

Regular expression matching (REM) and dictionary-based string matching (DBSM) have traditionally played a key role in text processing and database filtering. More recently, they have been utilized widely in network intrusion detection systems (NIDS) for virus scanning and deep packet inspection (DPI). Due to their computation and memory intensive natures, both REM and DBSM often bottleneck the NIDS, and can even be subject to performance-based denial-of-service (DoS) attacks. Yi-Hua E. Yang's Ph.D. research focuses on novel algorithms and designs that accelerate DBSM and REM on FPGA and multi-core systems. He proposed the *modified McNaughton-Yamada construction* which converts an arbitrary regular expression into a *modular NFA* (mNFA) suitable for implementation on FPGA. The mNFA can be further transformed to a *segmented regex-NFA* (SR-NFA) or a *semi-deterministic finite automaton* (SFA) for compute and/or memory optimization on multi-core systems. He also proposed the *head-body finite automaton* (HBFA) which partitions DBSM into a head DFA (H-DFA) and a body NFA (B-NFA). Compared with conventional Aho-Corasick DFA, HBFA takes less than 1/5 construction time and 1/10 run-time memory, and is multiple times more resilient to performance-based DoS attacks.

Reference:

Y-H. E. Yang and V. K. Prasanna, "Software Toolchain for Large-Scale RE-NFA Construction on FPGA," International Journal of Reconfigurable Computing, Vol. 2009, January 2009.

Name: Bardia Zandian

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Website: http://www-scf.usc.edu/~bzandian/

Advisor: Murali Annavaram

PhD Start Date: Summer 2008

Estimated Graduation: Fall 2012

Research Title: Reliability Aware Microprocessors

Research Summary:

My research has been on design and evaluation of novel microachitectural solutions to mitigate circuit reliability issues. As devices scale to smaller dimensions, circuit lifetime reliability is reduced due to increased stress factors such as higher current density, electric field, and operation temperature. This problem is compounded as the number of these unreliable devices which are put on the same chip grows and process variations increase. Circuit reliability degradation stems from many electro-physical phenomena such as Electromigration, Time Dependant Dielectric Breakdown (TDDB), Hot Carrier Injection (HCI), and Negative Bias Temperature Instability (NBTI). These phenomena manifest as gradual timing degradation and eventual breakdown of circuits, this is referred to as wearout which has been the main focus of my research. Design time prediction of expected wearout during the lifetime of complex circuits is becoming increasingly challenging. This is due to dependence of the wearout causing phenomena on process variations, changing operation environment conditions, and workload-dependent circuit utilization. While these uncertainties existed even before, severity of their impact is increased as devices are scaled. We've proposed a novel continuous reliability monitoring framework based on adaptive runtime critical path testing. This framework provides accurate and real-time measure of circuit's timing margin degradation.

Reference:

B. Zandian, W. Dweik, S. Kang, T. Punihaole, and M. Annavaram. WearMon: Reliability Monitoring Using Adaptive Critical Path Testing. *Dependable Systems and Networks (DSN)*, pages 151-160, 2010.

Name: Lihang Zhao

Email: lihangzh@isi.edu

Advisor: Jeff Draper

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2014

Research Title: Using Hardware Support Transactional Memory for Increased Performance

Research Summary:

Conduct research in the broad area of parallel computer architecture for high performance and reliability. Recent research activities include using hardware transactional memory for increased productivity as well as performance. Also involved in VLSI design project to investigate fabrication variability in sub-micron processing technology.

Controls

Name: Afshin Abadi

Email: abadi@usc.edu

Advisor: Petros Ioannou

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2013

Research Title: Routing Optimization

Research Summary:

Afshin worked with USC-CREATE (Center for Risk and Economic Analysis of Terrorism Events) lab to develop “PortSec” software which is port security risk analysis and resource allocation system software. He was responsible for developing the transportation part and as a result PortSec software can evaluate the economic impact of implementing any counter-measure in the port of LA/LB. He is working on number of projects with METRANS transportation center in fields of optimization and economic assessment. He is also responsible for developing urban navigation system with the CATT (Center for Advance Transportation Technologies) lab group at USC and mainly focuses on routing optimization algorithms and using microscopic traffic simulator to identify the most comfortable and efficient route for each driver. His main research area is network optimization and control.

Reference:

Afshin Abadi, Petros Ioannou, “ Modeling of Economic Impact of Implementing Counter-Measure on Container Terminals”, MSAHS-2010

Name: Vadim Butakov

Email: butakov@usc.edu

Advisor: Petros Ioannou

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Adaptive cruise control system with vehicle-to vehicle communication.

Research Summary: Currently adaptive cruise control systems in practice use only forward looking sensors. This approach demands considerable inter-vehicle following distance in order to provide safety. We propose an adaptive cruise control system that in addition to forward looking sensors uses vehicle-to-vehicle communication. This allows predicting the behavior of leading vehicle and varying following distance in order to smooth the following and providing emission benefits.

Name: Rajit Chatterjea

Email: rchatter@usc.edu

Advisor: Edmond Jonckheere

PhD Start Date: Fall 2007

Estimated Graduation: Fall 2013

Research Title: Study of the curvature of quantum and related networks

Investigation of Quantum Networks and its applications

Research Summary:

The work involves a mathematical analysis of both the curvature of networks as well as applications to quantum networks working on the basis of each edge satisfying Schrodinger's Equation. There is also a considerable amount of work done in curvature analysis and the stability of networks based on controlling curvature.

Name: Anantha Karthikeyan

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Advisor: Michael G. Safonov

PhD Start Date: Spring 2008

Estimated Graduation: Spring 2012

Research Title: LQ Feedback Formulation of H_∞ Output Feedback Control

Research Summary:

Our research demonstrates that with suitable notation the general case of H_∞ control can be handled directly without loop shifting, thereby simplifying both the representation and the computation of general H_∞ output-feedback controllers. In standard theory for general H_∞ output-feedback control and in the associated software, certain preliminary “loop-shifting” transformations are needed. These add unnecessarily to the complexity of the H_∞ theory and its implementation in software. By revisiting the “completion of squares” derivations for the general H_∞ output feedback problem without the usual assumptions or ``loop-shifting'' transformations to arrive at an ``all-solutions'' output feedback formulation for both the continuous and discrete-time cases.

Reference:

Anantha Karthikeyan and Michael G. Safonov, “LQ Approach to an All-solutions Formula for H_∞ Output Feedback Control”, in proc. 49th *IEEE* Conference on Decision and Control, Atlanta, GA, USA, Dec 15-17, 2010, pp. 3156-3161, *IEEE* Press, New York.

Name: Yun Wang

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Advisor: Petros Ioannou

PhD Start Date: Fall 2005

Estimated Graduation: Summer 2011

Research Title: Dynamic Variable Speed Limit Control, Design, analysis and Benefits

Research Summary:

Variable speed limit (VSL) systems, as one of the freeway control strategies among other Intelligent Transportation Systems (ITS), have been studied since 1970s. Currently, the incentive of using VSL has been mainly safety from the application point of view. However, benefits such as improved traffic flow rates, saved travel times, smooth speed and density distribution and possibly lower pollution have been conjectured in literature and in some cases analyzed using mainly macroscopic traffic models. Yun Wang has studied the problems of the design, analysis and evaluation of dynamic VSL controllers using both the traditional macroscopic traffic models and the more realistic microscopic models. She developed a simple virtual metering strategy followed a control engineering approach, where the control strategies are designed based on simplified models (in this case validated macroscopic traffic flow models) but applied and tested on validated microscopic traffic models under different traffic conditions. She has published several papers in journals and conference proceedings.

Reference:

Y. Wang and P. Ioannou, A New Model for Variable Speed Limits, *the Transportation Research Record: Journal of the Transportation Research Board* (TRR Journal), in press.

Name: Ryan K. Williams

Email: rkwillia@usc.edu

Website: asimov.usc.edu/~rkwillia

Advisor: Prof. Gaurav Sukhatme

PhD Start Date: Fall 2006

Estimated Graduation: Spring 2013

Research Title: Control, Cooperation, and Autonomy in Multi-Agent Systems with Applications of Distributed Intelligence

Research Summary:

The exponential rise in computational power coupled with the steadily declining size and the multiplicity of processing cores, along with the expansion of communication technologies has led to a recent explosion in highly capable, highly connected processing agents (e.g. mobile robotics, smart phones, etc.). The ubiquity of such agents has garnered significant attention from the research community leading to a wealth of frameworks and algorithms for attaining autonomy and intelligence in *single-agent* domains. However, the full potential of *multi-agent* systems remains largely untapped. Ryan Williams' Ph.D. research focuses on the exploitation of distributed multi-agent systems through intelligent control and cooperation, leading to systems with computational efficiency through concurrency, enhanced scale by spatiotemporal distribution, and robustness to failure via redundancy. His focus lies in the study of consensus algorithms for the decomposition of cooperative tasks, varied agent interaction topologies, and distributed applications of intelligence (e.g. cooperative inference, regression/classification, and optimization). Ryan is a Viterbi Dean's Fellowship recipient, has contributed to several published works in conferences such as IROS and OCEANS, and holds a U.S. patent for his work in high-speed AUVs.

Reference:

R. Williams, G. Sukhatme, Cooperative Multi-Agent Inference Over Grid Structured Markov Random Fields, *IEEE/RSJ International Conference on Intelligent Robots and Systems*, submitted (2011)

Name: Tao Yuan

Email: tyuan@usc.edu

Advisor: S. Joe Qin

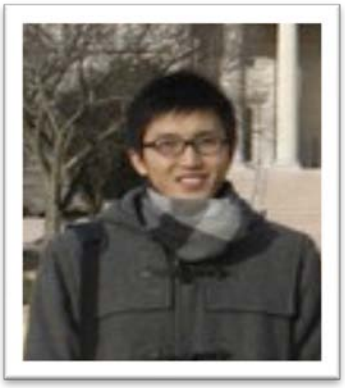
PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Controller performance monitoring and Oscillation diagnose

Research Summary:

Control valves suffered from stiction will cause oscillation in the process variables and propagate through the whole plant, which is very harmful to the production. My research work focus on monitoring the behavior of the control system, quickly detecting the oscillation if it occurs, and most important part is diagnose the source of the oscillation propagation. By using latent variable method and data mining based causality graph, we could successfully locate the source of the disturbance propagation and infer some useful process dynamics. Our method is data-driven and easy to implement in the industry.



Name: Yu Zhao

Email: yuzhao@usc.edu

Advisor: S. Joe Qin

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Application of subspace methods in system identification, fault detection and advanced process control

Research Summary:

Yu Zhao's Ph.D. research focuses on the application of the subspace methods for system identification and fault detection. He has developed the data based fault detection algorithm under the subspace framework and test the algorithm using AMD etching process. He also designed the system identification algorithm for the large delayed MIMO system.

Reference:

S. Joe Qin, Yu Zhao, Zhijie Sun, Tao Yuan, “Progressive Parametrization in Subspace Identification Models with Finite Horizons”, 49th IEEE Conference on Decision and Control, 2010.

Integrated Circuits & Systems

Name: Hooman Abediasl

Email: abediasl@usc.edu

Advisor: Hossein Hashemi

PhD Start Date: Fall 2010

Estimated Graduation: Fall 2015

Research Title: Toward Integrated Circuits at Optical Frequencies

Research Summary:

Since the invention of transistor, advancement in semiconductor electronic device technology has led to complex integrated systems covering a wide frequency range from DC to near 1-THz. The size of electronic building blocks in these systems is usually much smaller compared with the wavelength (0.3mm at 1-THz); hence, circuit analysis, a simplified form of Maxwell equations, is used throughout the systematic analysis and design process. Similar advancement in photonic device technology has enabled relatively complex Photonic Integrated Chips (PIC) operating at optical wavelengths (around 1μm). The approach towards analysis and designing PICs has been fundamentally different that of Integrated Circuits (IC) as the size of optical components (e.g., waveguide) is comparable and often much larger than wavelength. In other words, the size of a typical PIC is larger than that of an IC although optical wavelengths are smaller by a factor of 100-1000. Advancements in nano-technology enable manufacturing structures at the nanometer scale.

Hooman's research is focused on realizing complex optical systems where the size of components is comparable, or even smaller, than wavelength. Specifically, he intends to find equivalent circuit analysis and design methodology for such systems. Currently, he is studying plasmonic structures. Tiny metallic particles have a number of valuable optical properties that are derived from their ability to support collective light-induced electronic excitations, known as surface plasmons. The plasmonics field exploded when it was demonstrated that metallic nanowires enable much smaller optical circuitry than dielectric waveguides. A few novel passive structures have been established like plasmonic detectors that can meet the stringent power, speed, and materials requirements necessary to incorporate plasmonics into conventional electronics technology. Hooman is trying to capture the essence of plasmonic device structures (currently passives) and their interactions.

Name: Firooz Aflatouni

Email: aflatoun@usc.edu

Advisor: Hossein Hashemi

PhD Start Date: Fall 2005

Estimated Graduation: Spring 2011

Research Title: RF assisted phase control of semiconductor lasers

Research Summary:

Controlling the relative phase of multiple semiconductor lasers enables coherent power combining with high efficiency and optical beam steering. Conventional injection locking and Phase Locked Loop (PLL) techniques have been used to lock the frequency of multiple lasers. Firooz demonstrated several electro-optical PLLs that not only lock the frequency of multiple lasers, but also, enable controlling their relative optical phases in electrical domain.

The absolute phase variations of lasers due to noise, also known as the phase noise, limit the performance of several optical systems including interferometric sensing, coherent optical communications, LIDAR, and THz signal generation. Reducing the phase noise and line-width of lasers using optical or electro-optical methods has been an active area of research. Firooz has demonstrated several new electro-optical laser phase noise reduction schemes that are specifically suitable for integration and monolithic implementation. His latest result demonstrate that the line-width of a commercial 1550nm laser can be reduced from 7-MHz to around 1-KHz using a feed-forward electro-optical architecture.

These are examples of Electronic-Photonic Co-Design which can be categorized into two main aspects: (a) *RF Assisted Photonics* where RF and mm-wave circuits and techniques are employed to improve the performance of photonic systems, and (b) *Photonic Assisted Electronics* where photonic systems and devices are used to improve the performance of the RF and mm-wave systems.

Reference:

F. Aflatouni, M. Bagheri, and H. Hashemi, “Design methodology and architectures to reduce the semiconductor laser phase noise using electrical feed-forward schemes," *IEEE Tran. on Microwave Theory and Techniques,* vol. 58, no. 11, pp 3290-3303, November 2010.

Name: Run Chen

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Advisor: Hossein Hashemi

PhD Start Date: Fall 2009

Estimated Graduation: 2014

Research Title: Integrated System Design of Software Defined and Cognitive Radio Transceivers

Research Summary:

Frequency allocation regulations coupled with the rapid introduction of new wireless standards and applications have led to a high demand for integrated multi-mode, multi-band, and multi-standard wireless transceivers. The high nonrecurring engineering cost and development time associated with a new wireless transceiver hardware design has inspired the Software Defined Radio (SDR) concept where the same wireless transceiver can be programmed in software to support any existing or upcoming wireless standard. Even more radically, Cognitive Radio (CR) enables efficient usage of the frequency spectrum depending on the availability of "open" channels. The major challenge in designing SDR/CR receivers is maintaining high dynamic range over a wide frequency spectrum. Specifically, the receiver is required to amplify and process the desired RF signal in the presence of large undesired signals that, unlike fixed narrowband receivers, are not filtered immediately after the antenna. In addition, the receiver should also have functions such as input impedance matching, image rejection, harmonic rejection, etc, just like the requirements for conventional narrowband receivers.

Run Chen's PhD research focuses on the design of Software Defined and Cognitive Radio transceivers. The research includes solving challenges from the system level down to circuit design. Currently, he is working on RF signal processing in sample domain which can potentially achieve sufficient dynamic range and tuning flexibility. With the scaling down of CMOS technologies, the higher transit frequency of devices enables techniques traditionally used in low frequency analog design, to be implementable in the RF domain.

Name: Kunal Datta

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Advisor: Hossein Hashemi

PhD Start Date: Fall 2010

Estimated Graduation: Fall 2015

Research Title: Nonlinear Design Techniques for Highly Efficient MMIC Power Amplifiers

Research Summary:

The power consumption of most wireless communication systems is dominated by that of the Radio Frequency (RF) Power Amplifier (PA). Therefore, the power efficiency of the PA plays a key role in determining the overall system power consumption. Unfortunately, increasing power efficiency often comes at the expense of reduced linearity in the PA. Realizing highly efficient linear PAs has been the wholly grail of wireless communication hardware for several decades. For instance, the peak efficiency of a state-of-the-art PA in cellular phones (1-2GHz) is around 40% - 50%. The advancement in silicon process technology enables various PA linearization solutions and efficient transmitter architectures.

Kunal Datta is working towards realizing Efficient Linearized Silicon Transmitters at mm-waves. One specific objective is to demonstrate Watt-level silicon transmitters at 45-GHz and 94-GHz with over 65% efficiency and sufficient linearity to support 64-QAM with EVM < 2.5%. Kunal's research includes a fresh look into nonlinear analysis of radio frequency dynamical systems, device modeling, architectural studies, simulation, and experimental methods with special attention to power amplifier stability, parametric effects, breakdown and avalanche phenomena, and efficiency. For instance, while frequency dependent nonlinearity is historically regarded as a source of instability, if harnessed correctly, may indeed improve the amplifier efficiency.

Name: Viviane Ghaderi

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Website: http://cne.usc.edu/members/viviane.htm

Advisor: John Choma/Theodore Berger

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2013

Research Title: Ultra low power analog signal processing for bioelectronics

Research Summary:

Bioelectronics is an exciting new field that spans a broad range of applications, from electronics for implantable devices (such as the neural prosthesis which aims to replace parts of the hippocampus in order to restore/enhance memory function) to neuromorphic architectures (defined as VLSI architectures that mimic neuro-biological functions). Ultra low power consumption is one of the main requirements for most bioelectronics. Implantable chips are often battery powered and surgery is required to replace a dead battery. Other methods of powering implants, such as RF and inductive coupling, often provide low levels of power, limited either by poor coupling or by tissue damage due to excessive power absorption. Neuromorphic systems require the implementation of an extremely large number of neurons, synapses, and functions if precise and meaningful results are to be obtained. Hence, it is a pressing mandate to design for the lowest power level in each basic functional building block.

Subthreshold CMOS analog circuit design is a natural candidate for bioelectronics because of its low level of power consumption as well as the inherent exponential current-voltage relation of a transistor in subthreshold that can be used to mimic biological signals and emulate biomedical signal processing. Therefore, the goal of this research is to develop basic analog signal processing units with subthreshold transistors to model fundamental biological functions that can be effortlessly combined to form larger neuromorphic architectures and for implantable hardware.

Reference:

V. Ghaderi, S. Allam, N. Ambert, J-M. C. Bouteiller, J. Choma and T. W. Berger, “Modeling Neuron-Glia Interactions: From Parametric Model to Neuromorphic Hardware,” Proceedings of the 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 2011 (submitted)

Name: Ankush Goel

Email: ankushgoel@gmail.com

Advisor: Hossein Hashemi

PhD Start Date: Fall 2004

Estimated Graduation: Fall 2010

Research Title: Integrated Multi-Band And Wideband Reconfigurable Wireless Receivers

Research Summary:

Radio Frequency (RF) sensing and spectral analysis over multi-GHz frequency band benefits a vast range of applications including public safety, electronic war- fare, instrumentation, and cognitive radio. Today's solutions require significant reduction in size, weight, and power consumption. For instance, the Departments of Defense, Homeland Security, and Public Safety are interested in dismounted RF sensors from a few kHz to multi GHz that can be hand-carried by their personnel over long distances. Similarly, test and measurement industry is seeing a growing trend towards USB dongle-based instrumentation. Ankush Goel's research has been focused on developing a monolithic 100Hz- 6GHz CMOS RF vector signal/spectrum analyzer. The chip uses a two-step up-down conversion heterodyne scheme with robustness to various wide-band interference scenarios. The chip enables wireless spectrum analysis in USB-dongle form-factor. This work will be presented at IEEE RFIC Symposium on June 7th, 2011 in Baltimore, Maryland.

Reference:

Ankush Goel, Behnam Analui, and Hossein Hashemi, "A 130nm CMOS 100Hz–6GHz Reconfigurable Vector Signal Analyzer and Software-Defined Receiver", to be presented at IEEE RFIC Symposium on June 7th, 2011 in Baltimore, Maryland

Name: Alireza Imani

Email: imani@usc.edu

Advisor: Hossein Hashemi

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2012

Research Summary:

Generation of spectrally pure oscillations has been the topic of science and engineering for years. Applications of stable, accurate, spectrally-pure frequency sources span from communication systems, synchronous computation, and data conversion to spectroscopy and fundamental physical discoveries. Alireza Imani's research in this area consists of two distinct directions, namely, stochastic nonlinear dynamics and system level architectures.

A self sustained oscillator is defined as a nonlinear dynamical system with a limit cycle. The behavior of these dynamical systems under perturbations and noise determines the purity of the generated spectral line. Study of this behavior can lead to ideas to improve the spectral purity and understanding its limits. The governing nonlinear dynamics depends on the system topology and its constituent devices. Alireza has found the theoretical limits of Bulk Acoustic Wave (BAW) resonator based electrical oscillators, and experimentally demonstrated GHz oscillators with sub-10fs jitter.

Conventional system level techniques towards synthesizing a spectrally pure frequency source include phase locked loops and frequency stabilization techniques. The general idea is to improve the spectral purity of a target frequency given a stable reference oscillator or a low loss frequency discriminating device. Alireza is currently working towards alternative integrated frequency synthesis methods to improve the achievable spectral purity and provide other functionalities such as wide frequency tuning range.

Name: Zahra Safarian

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Website: http://www-bcf.usc.edu/~hosseinh/

Advisor: Hossein Hashemi

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2012

Research Title: Integrated Low Power and Energy Harvesting Systems for communication and bio-implanted systems

Research Summary:

Battery-less systems are becoming more important in many applications including sensor nodes, implantable devices, and passive Radio Frequency Identification (RFID) tags. These systems must harvest energy from ambient and consume low power for their sensing, computation, and communication functions. Zahra's main research focus has been on designing low power and energy harvesting systems. Specifically, she has demonstrated a passive wireless transponder where the energy of radio frequency waves is harvested and stored to enhance sensitivity of the wireless system in the receive mode. Zahra has also been working on radio frequency nonlinear dynamical systems, specifically, wideband oscillators and regenerative synchronous frequency dividers. Currently, she is working on low-power solutions for wirelessly powered implanted multi-electrode neural recording systems. Due to the limited source of power and the heat issue which can damage the brain cells, these systems need to process and transmit a large amount of the data with low power and in a compact area.

Reference:

Z. Safarian and H. Hashemi, "A Wirelessly-Powered Passive RF CMOS Transponder with Dynamic Energy Storage and Sensitivity Enhancement," (accepted) in *IEEE Radio Frequency Integrated Circuits (RFIC) Symposium Digest of Papers*, June 2011.

Name: Susan M. Schober

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Website: http://www-scf.usc.edu/~schober/

Advisor: John Choma

PhD Start Date: Fall 2006

Estimated Graduation: Spring 2013

Research Title: An Ultra-Low Power CMOS Transceiver for Biomedical Implant Applications

Research Summary:

Susan Schober is a Ph.D. Electrical Engineering-Electrophysics student at the University of Southern California (USC) Viterbi School of Engineering where she is conducting her thesis on Ultra-Low Power Radio Frequency (RF) and Analog Integrated Circuit (IC) Design, including Novel Transceivers for Wireless and Biomedical Applications, under the supervision of Dr. John Choma. Susan has 4 solid years of industry experience in CMOS (65nm, 90nm, 130nm, 180nm, and 350nm) IC Design, Custom Layout, and Device Testing that was acquired while interning in the multiple areas of Digital VLSI, RF, and Analog IC Design at Qualcomm Technologies, Broadcom, and Scintera Networks, respectively. 4 patents have been filed for a handful of the low power innovative integrated circuits she has designed at ISI. Susan's thesis research is supported by the DARPA REMIND Project (http://www.darpa.mil/dso/thrusts/bio/restbio_tech/remind/index.htm), NSF-ERC-BMES at USC (http://bmes-erc.usc.edu/), Texas Instruments (http://www.ti.com/), and MOSIS (http://www.mosis.edu/). Susan completed her Bachelor's of Science in Electrical Engineering (2006), Master's of Science Electrical Engineering (2007), Master's of Science in Engineering Management (2010), and all while at USC. She is a student member of Tau Beta Pi, Eta Kappa Nu, IEEE, SWE, and is the co-founder of the USC E.E. Ph.D. Women Group which leads outreach programs and aims to retain more women Electrical Engineers in the doctoral program at USC.

Reference:

US Provisional Patent Application No. 61/394,908 (Publication is currently being written on this work)

Name: Sushil Subramanian

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Advisor: Hossein Hashemi

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2014

Research Title: Fast Synchronization of Remotely Located RF Circuits

Research Summary:

Since the first observation of coupled pendulums by Christiaan Huygens in the 17th century, synchronization of dynamical systems is an active topic of research in electrical engineering, physics and applied mathematics. Most of the synchronization research has involved coupled oscillators, i.e., coupled nonlinear dynamical systems with a limit cycle. Synchronization offers many other flavors; pseudorandom and chaotic systems have been shown to synchronize, and the phenomenon of stochastic resonance involves noise synchronizing with a periodic signal.

The bulk of Sushil's research concerns the analysis and design of remotely located nonlinear dynamical radio frequency circuits that achieve synchronization and are not necessarily oscillatory. In this regard, the primary objective is fast synchronization, i.e. achieving entrainment between remotely located circuits within a certain time constraint. The potential applications include accurate real time wireless localization and imaging using remotely located collaborative sensors. A closely related topic of interest is frequency synthesis with fast frequency hopping. Currently, Sushil is also investigating circuits that can hop between multiple frequencies separated by multiple decades with high resolution, within nanoseconds of time, and with the lowest possible power consumption.

Nano-Science, Nano-Technology & MEMS

Name: Noppadol Aroonyadet

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Advisor: Professor Chongwu Zhou

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2014

Research Title: Applications of Nanomaterials in Electronic and Sensing Perspectives

Research Summary:

Nanomaterials possess several outstanding characteristic such as ultrahigh surface volume ratio and high electronic mobility. Therefore, they are widely manipulated for sensing and solar cell applications. In addition, they exhibit promising chances to overcome limitation of silicon based semiconductor technology. My research is related to nanomaterial synthesis for electronic and sensing applications. After synthesizing, nanomaterials are characterized to verify their chemical compound and physical characteristics such as crystal structure and orientation, length, diameter and shape. Sensors and electronic devices are fabricated from these materials in the clean room facilities. These devices are characterized by electrical instruments such as semiconductor analyzer before they are tested for their functions. For sensing experiment, sensors are chemically modified their surfaces to immobilize probe molecules for selectively binding to our target molecules like antigens or DNA sequences for disease diagnosis.

Name: Mehmet Aykol

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http://www.usc.edu/dept/engineering/eleceng/cronin_lab/index.html

Advisor: Steve Cronin

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Using electromechanical suspended carbon nanotube Resonators to investigate gas molecule and nanotube interactions

Research Summary: Miniaturization of sensors that read environmental parameters such as CO2 concentration, temperature, humidity and/or detect trace amounts of dangerous chemicals are highly needed to collect data for various purposes. However, with modern sensors miniaturization means loss of accuracy as the sensing medium gets smaller noise becomes an issue. Carbon nanotubes have been used for this reason as they are small and have very high surface-to-volume ratio which makes them the prime candidate for gas sensing purposes.

CNT gas sensors have already been realized, however the mechanisms and the physics behind how they work are not really understood as there is little work in the literature that show how these gasses bind to the surface of these CNTs. One of the key parameters is the binding energies of these gasses to the surface. These energies would provide a more accurate model for these devices so one can predict how CNT sensors would behave theoretically.

Reference:

Aykol et. al, Journal of Micromechanics and Microengineering, 2011, Submitted

Name: Hsiao-Kang Chang

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Advisor: Chongwu Zhou

PhD Start Date: Spring 2007

Estimated Graduation: Fall 2011

Research Title: One-dimensional Nanostructures for Novel Transparent Electronics and Biomedical Applications

Research Summary:

One-dimensional nanostructures such as nanowire and carbon nanotube have exhibited great potential toward sensors and electronics application due to their large surface to volume ratio and high intrinsic mobility. In this proposal, I will first present the recent achievements on sensor and electronics applications based on indium oxide nanowire and single-wall carbon nanotube (SWNT). Topics include biomarkers detection utilizing antibody mimic proteins as capture probes, whole blood bioassay with nanobiosensors, and high performance transparent electronics based on aligned SWNT. Proposed future experiments will be discussed along with the achievements. A systematic proposal of optimizing the nanosesing platform in terms of sensitivity, selectivity, manufacturability, portability, sample delivery, device structures, capture probes and uniformity of devices performance will be further described in the future work chapter.

Reference:

H. Chang et al., Label-Free, Electrical Detection of the SARS Virus N-Protein with Nanowire Biosensors Utilizing Antibody Mimics as Capture Probes", ACS Nano, 5, 1219 (2009)

Name: Yuchi Che

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Website: http://nanolab.usc.edu/

Advisor: Chongwu Zhou

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Summary:

Based on the unique electrical properties and dimension advantage of carbon nano-material, I work on the nano-electronic with this potential material, ranging from the synthesis of carbon nanotube, down to the application of carbon nanotube field effect transistor in wafer scale fabrication of digital circuit and high performance Radio frequency device.

Reference:

"Air-Stable Conversion of Separated Carbon Nanotube Thin-Film Transistors from p-Type to n-Type Using Atomic Layer Deposition of High-κ Oxide and Its Application in CMOS Logic Circuits", ACS Nano, J. Zhang, C. Wang, Y. Fu, Y. Che, and C. Zhou (2011)

Name: Shih-Jui Chen

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Website: http://mems.usc.edu/

Advisor: Eun Sok Kim

PhD Start Date: Fall 2004

Estimated Graduation: Spring 2011

Research Title: Piezoelectric MEMS

Research Summary:

Shih-Jui Chen's Ph.D. research focuses on the applications of piezoelectric microelectromechanical systems (MEMS) in the area of acoustic sensors, RF switches, and biosensors.

First, the RF MEMS switch can be used for a GHz switching application where a relatively narrow bandwidth of about 10% is needed (e.g., a phased array antenna). The RF MEMS switch can also be used in switching an array of capacitors for advanced cell phones that require wide tunable range of capacitance.

Second, frequency-multiplexed combinatory mass sensing with single data line was demonstrated through an arrayed film bulk acoustic resonators. Ligands, such as biotin was immobilized on the gold-coated FBAR surface to detect neutravidin-biotin interactions without use of any labeling or molecular tags.

Reference:

S.-J. Chen, C.Y. Lee, and E.S. Kim, “Integration of Piezoelectric Tunable Capacitors and Bonded-wire Inductors for Contactless RF Switch and Tunable Filter,” Sensors and Actuators A: Physical, vol. 165, no. 1, pp. 73-78, 2011.

Name: Chun-Yung Chi

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Advisor: Paul Daniel Dapkus

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: III-V Tandem Solar Cells growth on Silicon substrate

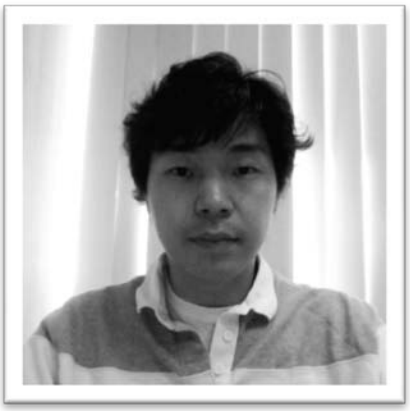
Research Summary:

III-V compound semiconductor nanowires are expected to provide excellent performance for photovoltaic application because of its superior light absorption and excellent carrier transport properties. Nanowire structure can also help to increase light absorption rate by re-absorbing reflected light from nanowire facets and release strain due to dissimilar lattice constant which made high quality III-V compound semiconductor growth possible on Silicon substrate.

Compare to vapor-liquid-solid growth, although selective-area growth for nanowire can avoid unintentional doping from catalyst, nano mask preparation for selective-area growth takes long time with electron-beam lithography which makes large area growth of noanowire difficult.

He works on III-V compound semiconductor synthesis with Metal Organic Chemical Vapor Deposition (MOCVD). III-V compound semiconductor growth on Silicon is his current topic for heterojunction tandem solar cell project. High crystalline quality of III-V compound semiconductor on Silicon is achieved with nanowire structure. He also works on large area nano-patterning for selective-area growth, in order to increase the efficiency of selective-area growth for III-V compound semiconductor. He has accomplished large area GaAs nanowire growth on Silicon with nano-sphere lithography techniques which made wafer scale nanowire growths feasible.

Name: Youngki Choe



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Advisor: Eun Sok Kim

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Acoustic Droplet Ejector Array

Research Summary:

My research is about acoustic micro-droplet ejector array which consists of 8 individual ejectors. Each of them fabricated on 127 μm-thick lead zirconate titanate(PZT) with top and bottom electrodes has its own micro-fluidic channel and reservoir to store liquid. The acoustic wave generated from PZT transducer is focused on a certain point on the liquid surface by Fresnel lens with air-reflector. By patterning transducer's electrode in pie shape, asymmetric acoustic wave can be generated. The asymmetric acoustic wave can eject droplets in non-vertical direction to the liquid surface (We call this type of ejector "directional ejector"). By building an array with directional ejectors, ejector array can ink a spot with different types of liquids without moving ejector. The possible applications of this research are on-demand protein synthesizer, in-situ DNA synthesizer, bio-chip fabrication, etc.

Reference:

Y. Choe, L. Wang, and E.S. Kim, " *On-chip Integration of Eight Directional Droplet Ejectors for Inking a Spot with Eight Droplets without Ejector Movement*," Transducers '11, IEEE International Conference on Solid-State Sensors and Actuators, Beijing, China, June 5 - 9, 2011(Accepted)

Name: Yue Fu

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Advisor: Chongwu Zhou

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: Nano electronics for display applications and integrated circuits

Research Summary:

Nano materials are potential semiconductive materials, due to their high mobility and high current carrying capacity endowed by their one dimensional or two dimensional structures. They are also ideal for flexible and transparent electronics. They even have great potential to work under formidable radiation environment.

Both one dimensional nanowires like ZnO and In_2O_3 nanowires, and two dimensional networks formed by single-walled carbon nanotubes are explored as channel materials for transistors in display pixel control circuits. These circuits are integrated with green light organic light emitting diode (OLED) matrixes or seven segment digits. They can turn on and off OLEDs, and also adjust the light intensity.

Among the two categories, nanotube networks are more scalable and have better device uniformity. Thereby, they are further explored for large-scale integrated circuits. By making both n-type and p-type carbon nanotube thin film transistors through tuning Schottky barrier presented at the metal/nanotube interface, CMOS integrated circuits based on carbon nanotubes are easy to fabricate, and this technology could share the same fabrication line with the mainstream silicon technology. Also, unlike the silicon technology-based circuits, they are radiation-compatible. Radiation test of these nanotube thin film transistors showed their robustness under severe radiation environment.

Name: Xue Lin

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Advisor: Professor Chongwu Zhou

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2014

Research Title: Controlled synthesis, characterization and integrated circuit application of carbon nanotubes

Research Summary:

Carbon nanotubes have been studied for their outstanding properties as a post-silicon semiconducting material. While exhibiting many extraordinary properties as high intrinsic carrier mobility, the carbon nanotubes need to be further developed for their integrated circuit applications. My research is about controlled synthesis, characterization and application of well aligned and highly dense carbon nanotubes. For nanoelectronics, defect free and predominantly semiconducting carbon nanotubes are most desirable. In order to obtain such carbon nanotubes, I applied controlled source, temperature and pressure during the synthesis. By using certain carbon sources under a range of temperature and pressure, the ratio of semiconducting carbon nanotubes can be improved. To confirm the ratio of semiconducting nanotubes, SEM, TEM, AFM, Raman scattering, Rayleigh scattering and electrical measurement are employed. Then, based on predominantly semiconducting carbon nanotubes, the 4-bit shifter is fabricated to demonstrate the integrated circuit applications of carbon nanotubes.

Name: Anderson Lin

Email: andersol@usc.edu

Advisor: Eun Sok Kim

PhD Start Date: Fall 2005

Estimated Graduation: Summer 2011

Research Title: Mass Sensing with Film Bulk Acoustic Resonator

Research Summary:

Anderson Lin's Ph.D. research focuses on the applications of radio frequency (RF) microelectromechanical systems (MEMS) in the area of film bulk acoustic resonator (FBAR) and its uses as a mass sensor in biological and chemical applications. FBAR, in its simplest form, is a resonator that consists of a piezoelectric thin film, usually zinc oxide (ZnO) or aluminum nitride (AlN), sandwiched by two electrodes. FBAR, with its miniature size and high mass sensitivity, has intrinsic advantages over other common types of resonant mass sensors. Anderson has worked on numerous mass sensing projects in various applications, both in vapor and liquid environments. He designed and fabricated FBAR for various sensing applications, and achieved selective detection of vapor traces of explosives (i.e., trinitrotoluene - TNT and cyclotrimethylenetrinitramine - RDX) with antibody coated sensors. He optimized FBAR for mass sensing in liquid environment and demonstrated label-free detection of DNA synthesis on the sensor surface. By utilizing chemical linkage for oriented antibody immobilization, he demonstrated selective detection of low prostate-specific antigen (PSA) concentration level that is of interest in prostate cancer studies.

Reference:

A. Lin and E. S. Kim, "Selectivity and Long-term Reliability of Resonant Explosive-Vapor-Trace Detection Based on Antigen-Antibody Binding," *IEEE International Micro Electro Mechanical Systems Conference,* Sorrento, Italy, January 25 - 29, 2009

Name: Jesse Theiss

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Website: http://www.usc.edu/cronin/

Advisor: Stephen B. Cronin

PhD Start Date: Fall 2004

Estimated Graduation: Spring 2012

Research Title: Engineering Strongly Plasmonic Nanostructures

Research Summary:

Advances in both top-down and bottom-up fabrication techniques have enabled the creation and design of structures with dimensions at the nano-scale. An exciting aspect of such small structures is the ability to focus light below the classical electromagnetic limits of conventional optics. Jesse's research focuses mainly on the design, fabrication, and characterization of metallic nanostructures aimed to generate significant enhancement of the electric field. This increase in electric field is known to enormously increase the Raman scattering intensity of molecules attached to the metal nanostructures, a process known as surface enhanced Raman spectroscopy (SERS), which is used to analyze the electromagnetic enhancement. Jesse's recent work combined electron-beam lithography with an angle evaporation technique to produce nanostructures with gaps as small as a single nanometer and provided a platform for SERS activity. His work has been published in the journal *Nano Letters* and presented at the March Meeting of the American Physical Society. He is also co-author on a number of peer-reviewed publications and has collaborated with the NASA Jet Propulsion Laboratory.

Reference:

Jesse Theiss, Prathamesh Pavaskar, Pierre M. Echternach, Richard E. Muller, and Stephen B. Cronin, Plasmonic Nanoparticle Arrays with Nanometer Separation for High-Performance SERS Substrates, *Nano Letters*, 10, 2749 (2010)

Name: Arash Vafanejad

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Website: http://mems.usc.edu

Advisor: Eun Sok Kim

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Microscale Rate Integrating Gyroscope

Research Summary:

My research is to develop fabrication techniques of a micromachined dome diaphragm and its post-process trimming for a microscale rate integrating gyroscope (MRIG). Fabrication is based on isotropic etching of silicon and deposition of thin films on the dome diaphragm. The dome diaphragm will be supported by a thin, flexible membrane that is intentionally wrinkled to provide room for the circular base of the dome diaphragm to vibrate in the second circumferential mode (or the 4-node wineglass mode). On the eight selected locations near the circular edge of the dome diaphragm, piezoelectric transducers will be formed by depositing metal and piezoelectric thin films through shadow masks. All eight piezoelectric transducers will be used for sensing, while four of those will be used to produce the 4-node wineglass mode. The wineglass mode will bifurcate into two (forward and backward) traveling waves with two different frequencies. The two traveling waves then produce a standing wave around the circumference of the circular edge of the dome base, which precesses in the opposite direction of the applied angular rotation, with its net precession angle being proportional to the net angle of rotation.

Name: Chuan Wang

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Website: http://nanolab.usc.edu/chuan.htm

Advisor: Chongwu Zhou

PhD Start Date: Fall 2007

Estimated Graduation: Summer 2011

Research Title: Carbon nanotube nanoelectronics and macroelectronics

Research Summary:

Owing to their extremely high intrinsic carrier mobility, high current carrying capacity, and possibility of ballistic transport, the 1-dimensional carbon nanotubes stand out as a strong candidate for beyond-silicon nanoelectronics. However, they also face significant assembly, integration challenges. Chuan's Ph.D. research focuses on the development of scalable approach for the fabrication of practical and realistic carbon nanotube transistors and integrated circuits. He has developed the wafer-scale aligned carbon nanotube synthesis and transfer technique that enabled the fabrication of high-performance nanotube transistors, RF transistors, and integrated circuits. He also pioneered in overcoming the major hurdle in nanotube field which is the coexistence of metal and semiconducting carbon nanotubes. By using high purity semiconducting carbon nanotubes separated by density gradient ultracentrifugation, he has developed a highly scalable solution-based separated nanotube deposition technique, demonstrated the fabrication high performance separated carbon nanotube thin-film transistors, and their application in display electronics, integrated circuits, and transparent/flexible electronics. Chuan has published 15 journal papers with multiple papers on top notch journals including *Nano Letters* and *ACS Nano*, 20 conference presentations, and his work on nanotube display electronics has been reported by *MIT Technology review*.

Reference:

C. Wang et al., Wafer-Scale Fabrication of Separated Carbon Nanotube Thin-Film Transistors for Display Applications, *Nano Letters*, Vol. 9, 4285-4291, (2009)

Name: Lingtao Wang

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Website: mems.usc.edu

Advisor: Eun Sok Kim

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Development of MEMS piezoelectric transducers for micro-fluidic actuators and biomedical applications

Research Summary:

Lingtao Wang's Ph.D. research focuses on the development of Micro Electro-Mechanical System (MEMS) piezoelectric transducers for micro-fluidic actuators and biomedical applications. He has designed, simulated and fabricated acoustic ejectors with acoustic focus lens based on a Lead zirconate titanate (PZT) substrates. With a novel design of "phase-varied" acoustic lens, ejectors are able to generate nano-liter micron-sized droplets with the electrical control of the direction of droplet ejection. He is currently developing a MEMS acoustic transducers array for localized cell lysis, which will be employed in a cancer diagnosis system. By using Sefl Focused Acoustic Transducer (SFAT) to focus acoustic beam at the focal point, he has fabricated a single MEMS cell lyser, and demonstrated the localized cell lysis of monolayer prostate cancer cell line 22RV1 with the size of treatment area being 100 μm in diameter. His future research plan is to develop a fully functional lab-on-a-chip for cancer diagnosis and cancer therapeutics.

Reference:

L. Wang, Y. Choe, and E. S. Kim, "*Electrical Control of Droplet Direction with Phase-Varied Fresnel Lens on Acoustic Wave Liquid Ejector*," IEEE International Micro Electro-Mechanical Systems Conference, Cancun, Mexico, January 23 – 27, 2011, pp. 1115-111

Name: Maoqing Yao

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Advisor: Chongwu Zhou

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Synthesis of nanowires and its application in third generation solar cells

Research Summary:

III-V compound semiconductor nanowires arrays are expected to provide excellent performance for photovoltaic application and are of intensive research interest due to their direct band gap, superior enhancement of light absorption and excellent carrier transport properties. Also nanowire can release strain that is caused by material with dissimilar lattice constant, making direct integration of III-V compound semiconductor and silicon feasible, which can yield high performance system with relatively low cost by using mature fabrication process in silicon industry. My research focus is synthesizing these nanowires and using them to fabricate multi-junction solar cells which will provide higher energy conversion efficiency than the traditional single junction solar cells and lower the cost of tandem cells due to cheap silicon substrate and small amount of material required by nanowires. We also study the fundamental physical properties of the nanowires to ensure good performance of cells made from them. We study the enhancement of light absorption due to the geometry of nanowires by both experiment and numerical simulation. We also investigate other intrinsic optical and electrical properties of nanowires using nanowire FET measurement, and other advanced characterization techniques, such as transmission electron microscopy, photoluminescence, Raman spectroscopy etc.

Name: Ting-Wei Yeh

Email: tingweiy@usc.edu

Advisor: P. Daniel Dapkus

PhD Start Date: Spring 2005

Estimated Graduation: Fall 2011

Research Title: GaN nanostructures grown by selective area growth for light emitting diodes

Research Summary:

InGaN/GaN is a promising candidate material for solid-state lighting; however, two inherent difficulties with this material affect its efficiency as an efficient light emitting material. Namely high dislocation density resulting from large lattice mismatch between the GaN materials and the sapphire substrates upon which they are grown, and also the presence of large polarization and piezoelectric fields caused by the strain inside the active region. Ting-Wei Yeh's Ph.D. research focuses on exploring novel GaN nanostructures to reduce the dislocation density of the GaN material and to eliminate the piezoelectric field formed inside the InGaN/GaN multiple quantum wells by growing the heterostructures on the nonploar planes of GaN nanostructures. He has demonstrated the selective area growth of uniform arrays of GaN nanostructures, including nanopyramids, nanorods, and nanosheets. Light emission from InGaN/GaN multiple quantum wells grown on GaN nanostructure arrays are successfully achieved. The nanostructures are expected to improve the efficiency of blue/green light emitting diodes for solid-state lighting.

Reference:

Hyung-Joon. Chu, Ting-Wei Yeh, Lawrence Stewart, P. Daniel Dapkus, Phys. Status Solidi C 7, No. 10, 2494–2497 (2010)

Name: Jialu Zhang

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Website: http://nanolab.usc.edu/

Advisor: Chongwu Zhou

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

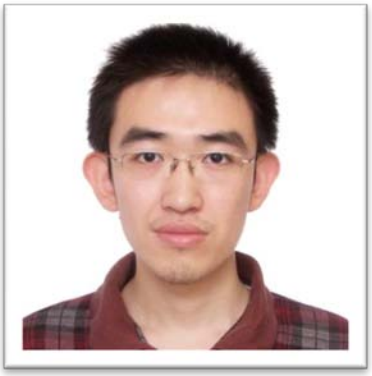
Research Title: Wafer-scale Fabrication of Separated Carbon Nanotube Thin-film Transistors for CMOS Logic Circuit and Display Applications

Research Summary:

Due to the extraordinary electrical property, preseparated, high purity semiconducting carbon nanotubes hold great potential for thin-film transistors (TFTs) and integrated circuit applications. The main challenges it still faces are the scalable assembly method and the fabrication of air-stable n-type nanotube TFTs with industry compatible techniques for CMOS integrated circuit applications. Jialu Zhang's Ph.D. research focuses on the development of scalable approach for the fabrication of carbon nanotube transistors and integrated circuits. He has developed a solution-based separated nanotube deposition technique and overcame one of the major difficulties in the carbon nanotube field which is the absence of a stable way to fabricate n-type transistors. He has demonstrated the fabrication high performance CMOS separated carbon nanotube thin-film transistors, and their application in display electronics, integrated circuits, and transparent/flexible electronics. His work has been published on top notch journals including *Nano Letters* and *ACS Nano* and the work on nanotube display electronics has been reported by *MIT Technology review*.

Reference:

Jialu Zhang, Chuan Wang, Yue Fu, Yuchi Che, and Chongwu Zhou. "Air-Stable Conversion of Separated Carbon Nanotube Thin-Film Transistors from p-Type to n-Type Using Atomic Layer Deposition of High-κ Oxide and Its Application in CMOS Logic Circuits", ACS Nano, ASAP, 2011



Name: Zhen Li

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Advisor: Chongwu Zhou

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2014

Research Title: High Performance Graphene FET

Research Summary:

Graphene, a single-layer carbon atom sheet, which has the same hexagon structure as graphite, is considered as a very promising candidate for high performance FET, because its ultrahigh mobility and carrier density. The mobility of suspended graphene has been reported as high as 200,000 $cm^2V^{-1}s^{-1}$ at low temperature, and mobility of graphene on boron nitride substrate can reach 60,000 at room temperature, which is almost 100 times higher than silicon. Large scale high quality graphene can be acquired by LPCVD. Zhen's research interest is to study of fabricate high performance graphene FETs with CVD or exfoliated graphene.

Networks

Name: Joon Ahn

Email: joonahn@usc.edu

Website: http://anrg.usc.edu/~joonahn

Advisor: Bhaskar Krishnamachari

PhD Start Date: Spring 2006

Estimated Graduation: Summer 2011

Research Title: Optimizing Information Dissemination in Wireless Networks

Research Summary:

Disseminating shared information to many vehicles could incur significant access fees if it relies only on unicast cellular communications. The dependence on limited cellular communication can be remarkably decreased if P2P communications are also employed between vehicles. As one of his PhD studies, Joon Ahn consider the problem of efficient content dissemination over a heterogeneous vehicular network, in which vehicles are equipped with a high-cost long-range cellular radio, and a free short-range radio. He has analyzed the dissemination process of information in the P2P network, has derived the optimum number of cellular accesses to maximize the dissemination using P2P mode cost-effectively. He also has verified the results through simulation studies with real GPS trace data of more than 600 taxis. Besides this study, he has interests in many other wireless computer networks. He has derived analytically scaling laws of data-centric wireless sensor networks, has modeled the energy cost of expanding-ring searches, and has derived the throughput capacity of modified ALOHA protocol for underwater networks. He has published 5 conference papers and 3 journal papers including one on ACM/IEEE Transactions on Networking.

Reference:

Joon Ahn and Bhaskar Krishnamachari, 'Scaling Laws for Data-Centric Storage and Querying in Wireless Sensor Networks', *IEEE/ACM Transactions on Networking*, Vol 17, Issue 4 (Aug 2009)

Name: Majed A. Alresaini

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Advisor: Bhaskar Krishnamachari

PhD Start Date: Fall 2006

Estimated Graduation: Spring 2012

Research Title: Backpressure with Adaptive Redundancy (BWAR)

Research Summary:
Designing optimization algorithms in computer networks and analyzing them using probabilistic methods and mathematical models. My research interests include stochastic network optimization, cross-layer protocols, backpressure, delay-tolerant networking (DTN), and intermittently connected mobile networks (ICMN). I introduced a new novel adaptive redundancy method that solves high latency problem associated with backpressure when the load to the network is low. This adaptive redundancy method assures network stability whenever arrivals are inside the capacity region and it is guaranteed that it does not perform worse than regular backpressure in terms of delay and throughput.

Name: Dilip Bethanabhotla

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Advisor: Giuseppe Caire

PhD Start Date: Fall 2010

Research Title: Optimizing video streaming experience for a user in a cellular wireless network

Research Summary: A common experience in streaming video is the 'stalling' effect which essentially means that the video being currently watched (Youtube or Netflix) alternates between playing and stopping causing the status “Buffering” or “Loading” to appear on screen. Stalling should be minimized for a satisfactory viewing experience. We can reduce the quality of the video (low definition) and make sure that stalling is rare. But, bad quality video also is obviously unsatisfactory to the viewing experience. We wish to design transmission policies which seek a graceful trade-off between the quality of the video and the probability of stalling. Our goal is to ensure that the probability of stalling is low while simultaneously maintaining a high average quality of the video streamed thereby enhancing user experience.

Name: Hao Feng

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Advisor: Andreas F. Molisch

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Cooperative Wireless Communication

Research Summary:

Through cooperation, multiple nodes in wireless network work together to form a virtual antenna array and achieve the spatial diversity of traditional MIMO techniques without each node necessarily having multiple antennas. Moreover, multi-hop network enables the intermediate nodes to forward the message from source to destination through certain form of cooperation. However, when cooperative communication is used for forwarding the message, the routing problem and resource allocation problem become more complex issues. Hao Feng's Ph.D. research focuses on the cross-layer designing approach for optimizing the routing and resource allocation in cooperative wireless network. He has been researching on stochastic network optimization algorithms based on minimizing Lyapunov drift plus penalty. He is now exploring combining those routing and resource allocation approaches with mutual information accumulation technique based on rateless code, in order to develop the optimal cross-layer routing and resource allocation strategy.

Name: Yi Gai

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Website: http://www-scf.usc.edu/~ygai/

Advisor: Bhaskar Krishnamachari

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Online Learning Algorithms for Network Optimization with Unknown Variables

Research Summary:

Yi Gai received her B.E. and M.S. in Electrical Engineering from Tsinghua University, Beijing, China in 2005 and 2007, respectively. She is currently a Ph.D. candidate in the Autonomous Network Research Group, Department of Electrical Engineering, University of Southern California. Yi Gai's research, which is algorithmic and theoretical in its focus, spans the areas of machine learning, network optimization, mobile computing, game theory, and cognitive radio networking. Yi Gai has published more than 10 papers with multiple papers on top conference including IEEE INFOCOM. She is the recipient of the Annenberg graduate fellowship 2007-2009.

Reference:

Yi Gai, Bhaskar Krishnamachari and Rahul Jain, "Learning Multiuser Channel Allocations in Cognitive Radio Networks: A Combinatorial Multi-Armed Bandit Formulation", IEEE Symposium on International Dynamic Spectrum Access Networks (DySPAN 2010), Singapore, April, 2010.

Name: Thilan Ganegedara

Email: ganegeda@usc.edu

Website: http://sites.google.com/site/thilangane/

Advisor: Viktor K. Prasanna

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Hardware and Power Efficient Architectures for Router Virtualization and Traffic Classification

Research Summary:

Due to the traffic generated by the myriad of devices connected to the Internet, and proliferation of multimedia traffic, modern routers are struggling to meet the stringent Quality of Service (QoS) and throughput demands. The goal of Thilan Ganegedara's Ph.D. research is to devise hardware and power efficient architectures for high-speed next generation backbone routers. He is considering two prominent techniques to achieve his goals: 1) Router virtualization – to improve the efficiency of underutilized router hardware, and 2) Traffic classification – to facilitate a router with application based traffic prioritization. His work will consist of software frontends for preprocessing and hardware backends for implementation. His current focus is on high performance parallel router architectures on reconfigurable hardware. Through a mix of machine learning techniques, data structures and algorithms, his research will lay a healthier foundation for the future Internet infrastructure.

Reference:

Thilan Ganegedara, Weirong Jiang, Viktor K. Prasanna, "FRuG: A Benchmark for Packet Forwarding in Future Networks", 29th IEEE International Performance Computing and Communications Conference (IPCCC 2010), Albuquerque, New Mexico, USA, December 2010

Name: Harsha Honnappa

Email: honnappa@gmail.com

Advisor: Rahul Jain

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Games and Queues

Research Summary:

Our current research is at the intersection of Game Theory and Queueing Theory. There are two components to our current work. Firstly, we are studying the effect of strategically arriving jobs at queues, by modeling the strategizing behavior as a non-atomic game. We have also studied strategic arrivals into simple networks of queues. In the paper listed below, we show the existence and uniqueness of the equilibrium arrival distribution, and also analyze the Price of Anarchy of the strategic arrivals game.

The second part of our work involves developing large population approximations to the queueing systems in question. In general it is very difficult, if not impossible, to study the transient behavior of the queue performance measures, such as the queue length and the workload process. It is easier to analyze the behavior of the queueing system as the number of arriving jobs increases to infinity. We have developed large population Functional Strong Law of Large Numbers and Functional Central Limit Theorem results that describe the queue length and workload performance measures, under different scalings of the number of arrivals. This research work is being conducted with Prof. Amy Ward of the Marshall School of Business.

Reference:

Harsha Honnappa, Rahul Jain, "Strategic Arrivals into Queueing Networks," The Allerton Conference, August 2010.

Name: Dileep Kalathil

Email: manisser@usc.edu

Advisor: Rahul Jain

PhD Start Date : Fall 2009

Estimated Graduation : Spring 2014

Research Summary:

My research focuses on two different areas. In the first project, I am trying to develop Game theoretic mechanisms to solve spectrum sharing problems, particularly for cognitive radio network. When the users in the network are perfectly cooperating, information theory provides the methods to increase the network capacity. However, in a decentralized system, each user in the network can be selfish and may care only about his own utility. So, the users may not cooperate without right incentives. In our work, we study mechanism design for cooperative communication when the users are non-cooperative. The other half of the work is focussed on Markov Decision Processes (MDPs) and distributed control. It is well known that dynamic programming based solutions for MDPs suffers from the curse of dimensionality. In our work we are developing an empirical dynamic programming approach to solve these problems. In distributed control, we are interested in the problems of controlling a system via sensors and controllers distributed over a network. One aspect is to find the fundamental limits on the data rate requirement of the network to ensure closed loop stability or to minimize a particular cost function. Second aspect is to find the optimal distributed control laws for such systems.

Reference:

1. Dileep Kalathil, Rahul Jain, “A contract based approach for spectrum sharing in cognitive radios”, Proceedings of WiOpt, June 2010

Name: Angelos Lazaris

Email: alazaris@usc.edu

Website: http://www-scf.usc.edu/~alazaris/

Advisor: Konstantinos Psounis

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2014

Research Title: Modeling and Performance Evaluation of Communication Networks

Research Summary:

Angelos Lazaris' research interests span the broad area of communication networks and systems. His goal is to develop efficient protocols and algorithms that use traffic modeling in order to improve the performance of several types of networks such as the Internet, wireless networks, cellular networks and satellite networks. His current research is focused on anomaly detection in Online Social Networks and the Internet. Angelos has published 5 journals papers and 6 conference presentations in the above-mentioned areas. He was also the recipient of the best diploma thesis award from Ericsson for his research work on modelling MPEG-4 videoconference traffic.

Reference:

A. Lazaris, P. Koutsakis and M. Paterakis, "On Modeling Video Traffic Originating from Multiplexed MPEG-4 Videoconference Streams", Performance Evaluation Journal, Elsevier Publ., Vol. 65, No. 1, 2008, pp. 51-70

Name: Hoang Le

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Advisor: Viktor K. Prasanna

PhD Start Date: Fall 2007

Estimated Graduation: Summer 2011

Research Title: High Performance Architectures for Large Scale Packet Forwarding and String Matching

Research Summary:

My research spans from high-performance packet forwarding architectures used in network routers to dictionary-based string matching used in network security. I have also done research in secured embedded systems and cryptographic hardware. My primary focus is on algorithm design, algorithm mapping on custom hardware, memory efficient data structures, and high-speed architectures.

Reference:

Hoang Le and Viktor K. Prasanna, A Memory-Efficient and Modular Approach for String Matching on FPGAs, 18th IEEE Symposium on Field Programmable Custom Computing Machines 2010 (FCCM '10), April 2010.

Name: Chih-ping Li

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Website: www-scf.usc.edu/~chihpinl

Advisor: Michael J. Neely

PhD Start Date: Fall 2005

Estimated Graduation: Summer 2011

Research Title: Stochastic optimal control over partially observable wireless networks and multi-class queueing systems

Research Summary: My research focuses on solving stochastic scheduling problems in two areas: restless multi-armed bandit problems (RMAB) and multi-class queueing systems (MCQS). RMAB and MCQS are classical stochastic control models that have been studied for decades, mostly with linear objective functions to optimize. Modern applications in wireless networks and computer systems, however, raise many open nonlinear control problems. These problems are difficult to solve using traditional approaches such as optimization theory or Markov decision theory, and a new solution methodology is required.

The main contribution of my research is to develop a new optimization methodology to solve the nonlinear control problems. First, I characterize the performance region in every problem as a convex hull of a set of performance vectors. Then I use and generalize the Lyapunov drift theory to greedily construct a dynamic control policy whose performance is provably near-optimal using the first step. The resulting policy uses a novel Max-Weight ratio rule, which generalizes the well-known Max-Weight policy in time-slotted wireless networks to frame-based systems in which the frame size is random and policy-dependent.

The modern applications of RMAB and MCQS include limiting channel probing in partially observable wireless networks, improving spectrum efficiency in cognitive radios, and power-aware CPU scheduling problems.

Reference:

C.-P. Li and M. J. Neely, Network utility maximization over partially observable Markovian channels, accepted by Intl. Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (Wiopt), May 2011.

Name: Shuping Liu

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Website: http://www-scf.usc.edu/~lius/

Advisor: Cauligi S. Raghavendra

PhD Start Date: Fall 2006

Estimated Graduation: Summer 2011

Research Title: Intelligent Control and Anomaly Detection/Prediction in Sensor based Systems

Research Summary:

Shuping Liu has broad research interest in areas of wireless body sensor networks, anomaly detection/prediction, wired and wireless networking, wireless communication, network security, machine learning and data mining. He is conducting his Ph.D thesis on Intelligent Control and Automatic Anomaly Detection/Prediction in Sensor-based Systems. He has developed an innovative policy-based MDP energy efficiency control algorithm for Health Monitoring Systems and he also has successfully applied Advanced Machine Learning Techniques for failure detection/prediction of a rod pump lift system for the Chevron Company, which saves a large amount of labor costs and has improved production at Chevron. Shuping has extensive experience working on algorithms for network security and optimization. He completed his M.S. degree (2004) in Electrical and Communication Engineering with an emphasis in Network Technology at Helsinki University of Technology in Finland. His Master's thesis was on the Teletrafic Theorem which involves Data Traffic Performance Analysis of a Cellular System with a Finite User Population. Shuping also has completed a 2nd M.S. degree (2010) in Computer Science from USC. Shuping obtained his B.S. Degree (1998) at Anhui University of Technology in China where he was a top student and the President of the Student Scientific Committee.

Reference:

S. Liu et al., MDP Framework for Sensor Network Coordination, the 8th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), San Francisco, CA, USA, April 2009.

Name: Antonios Michaloliakos

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Advisor: Konstantinos Psounis

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2014

Research Title: Probabilistic modeling of Wireless and Delay-Tolerant networks. Probabilistic analysis of financial models.

Research Summary:

Antonios Michaloliakos' research interest spans among the wide field of Wireless and Delay-Tolerant Networks. His focus is on probabilistic modeling of networks and development of efficient routing protocols to exploit the special structure of these networks. Recently he has developed an interest on financial engineering and mathematical finance problems.

Name: Maheswaran Sathiamoorthy

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Advisor: Bhaskar Krishnamachari

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: Coding for Distributed Storage Systems

Research Summary:

With the advent of cloud computing, more and more data is pushed into the cloud. This brings along many important challenges such as finding optimal storage schemes to minimize delay, protecting data from machine failures and so on. The current trend to overcome data loss from machine failures is to replicate data as many times as possible. Instead, the use of erasure codes can not only help minimize the storage required but also ensure equal or better data loss resilience than simple replication. Maheswaran Sathiamoorthy's research interests are aligned along this direction, in designing efficient distributed storage systems, especially with the help of coding techniques. In the past, he has worked on designing coded storage strategies for highly dynamic networks like vehicular networks. He was able to demonstrate analytically and using real taxi traces that in a vehicular network setting, when storing data in vehicles, coding performs better than replication in minimizing the delay in downloading a file from multiple vehicles under bandwidth constraints. Further, he is also interested in devising algorithms for efficient data dissemination in delay tolerant dynamic social networks.

Reference:

Maheswaran Sathiamoorthy, Alexandros G. Dimakis, Bhaskar Krishnamachari, Fan Bai, "Distributed Storage Codes Reduce Latency in Vehicular Networks", submitted to ACM Sigcomm 2011.

Name: Kyuho Son

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Website: http://anrg.usc.edu/~kyuho

Advisor: Bhaskar Krishnamachari

Postdoc Start Date: April 2010

Estimated Graduation: Post-doc

Research Title: Towards Green Cellular Networks

Research Summary:

The operation of cellular network infrastructure incurs significant electrical energy consumption. From the perspective of network operators, reducing this consumption is not only a matter of showing environmental responsibility, but also of substantially reducing their operational expenditure. Dr. Son's postdoctoral research focuses on how dynamic operation of cellular base stations (BSs), in which redundant BSs are switched off during periods of low traffic such as nighttime, can provide significant energy savings. For this purpose, he first has developed a theoretical framework that encompasses dynamic BS operation and the related problem of user association together. The framework enables him to investigate a flexible tradeoff between flow-level performance such as delay and the cost of energy. Furthermore, he has quantitatively estimated the potential energy savings (up to 70% depending on the configurations) through extensive simulations based on acquired real traffic traces and BS topologies in part of Korea and Manchester, UK. Dr. Son has published more than 15 research papers in journals/conferences, filed 10 Korea and U.S. patents, and also has been serving as a Web Chair of WiOpt 2009 and IEEE SECON 2011 Workshop on Green and Sustainable Communication Networks (GASCoN).

Reference:

K. Son, E. Oh and B. Krishnamachari, "Energy-Aware Hierarchical Cell Configuration: from Deployment to Operation," in *Proc. IEEE INFOCOM 2011 Workshop on Green Communications and Networking*, Shanghai, China, Apr. 2011.

Name: Stephen Suryaputra

Email: suryaput@usc.edu

Advisor: Joseph D. Touch

PhD Start Date: Fall 2009

Estimated Graduation: Fall 2013

Research Title: A Comparative Study of Approaches for Optical Packet Aggregator

Research Summary:

The bandwidth requirements of packet switching networks have been increasing. Multimedia is an example application that drives such increases. Uncompressed 1080 HDTV requires 1.2Gbps. Ultra HDTV requires 27Gbps. Even though video stream is commonly compressed and is only sent deltas, hence reduces the bandwidth requirement to 40 and 628 Mbps, the cumulative bandwidth requirement of multiple such a stream is still large. This is an *aggregation issue* and also is applicable for non-multimedia application. High bandwidth of optical fiber links can be used to aggregate a number of lower bandwidth access links. This requires an aggregation device. Supporting optical packet switching networks requires different approaches to the design of the device. Here I do a comparative study of those approaches and propose an Optical Packet Aggregator that incorporates existing approaches to form a different kind of device.

Reference:

S. Suryaputra, J. D. Touch, and J. A. Bannister, "Lookahead Forward Shift Optical Packet Switch," in *INFOCOM IEEE Conference on Computer Communications Workshops , 2010*, 2010, pp. 1-2.

Name: Wenyuan Tang

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Advisor: Rahul Jain

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2014

Research Title: Game Theory and Mechanism Design in Networks

Research Summary:

Wenyuan's primary research area is networking, with a focus on network game theory, which studies problems that arise in multi-player games where the players are connected through a social or communication network. His research is quite interdisciplinary, involving areas such as microeconomics, game theory, queueing theory and optimization. He is currently working on mechanism design problems for network resource allocation. His ultimate goal is to develop a theory of network market design.

Reference:

"Hierarchical auctions for network resource allocation", with Rahul Jain, Proceedings of the 2nd International ICST Conference on Game Theory for Networks (GameNets), Shanghai, China, April 2011.

Name: Rahul Urgaonkar

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Website: http://www-scf.usc.edu/~urgaonka/

Advisor: Michael J. Neely

PhD Start Date: Fall 2005

Estimated Graduation: Spring 2011

Research Title: Optimal Resource Allocation And Cross-Layer Control in Cognitive and Cooperative Wireless Networks

Research Summary:

We investigate optimal resource allocation and cross-layer control in cognitive and cooperative wireless networks with time-varying channels. We study different models and capabilities associated with cognition and cooperation in such networks. Specifically, we first consider the dynamic spectrum access model for cognitive radio networks where the secondary users try to avoid interfering with the primary users while seeking transmission opportunities on vacant primary channels in frequency, time, or space. We then consider a relay-based fully cooperative wireless network. Here, cooperative communication techniques at the physical layer are used to improve the reliability and energy cost of data transmissions. The third problem considers a cooperative cognitive radio network where the secondary users can cooperatively transmit with the primary users to improve the latter's effective transmission rate. In return, the secondary users get more opportunities for transmitting their own data when the primary users are idle. In all of these scenarios, our goal is to design optimal control algorithms that maximize time-average network utilities (such as throughput) subject to time-average constraints (such as power, reliability, etc.). To this end, we make use of the technique of Lyapunov optimization to design online algorithms that can operate without requiring any knowledge of the statistical description of network dynamics (such as fading channels, node mobility, and random packet arrivals) and are provably optimal.

Reference:

R. Urgaonkar and M. J. Neely, “Opportunistic Scheduling with Reliability Guarantees in Cognitive Radio Networks”, IEEE Transactions on Mobile Computing, vol. 8, no. 6, pp-766-777, June 2009.

Name: Sudhir Vinjamuri

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Website: http://www-scf.usc.edu/~vinjamur/

Advisor: Viktor Prasanna

PhD Start Date: Spring 2008

Estimated Graduation: Spring 2013

Research Title: Hierarchical Dependency Graphs

Research Summary:

Today's computing revolution is driven by massive on-chip parallelism. For the foreseeable future, high performance computing machines will almost certainly be equipped with nodes featuring multicore processors where each processor contains several full featured general purpose processing cores, private and shared caches. So the primary motivation of my work is to study, how ”classical” algorithms can be ”recycled” now that parallel computing has a renaissance with the advent of multicore computers. Also, the configurable platforms of systolic arrays pale out in comparison with multicore processors of comparable area and cost in terms of raw compute power and peak performance achievable due to high clock rate, chip density and economies of scale of multicore processors. Hence, it is highly desirable to extract parallelism and pipelining necessary for systolic array designs from multicore processors. If done intelligently, this will result in highly optimized performance since those properties are inherent to multicore architectures. To the best of my knowledge, there is no known prior work to map dependency graphs or systolic arrays to the current generation of multicore processors. I believe this is the first attempt for studying this problem.

Reference:

Sudhir Vinjamuri and Viktor K. Prasanna, Transitive Closure on the Cell Broadband Engine: A study on self-scheduling in a multicore processor, 23rd IEEE International Parallel and Distributed Processing Symposium (IPDPS '09), May 2009

Name: Yi Wang

Email: wangyi@usc.edu

Website: http://www-scf.usc.edu/~wangyi

Advisor: Bhaskar Krishnamachari & Murali Annavaram

PhD Start Date: Spring 2007

Estimated Graduation: Spring 2011

Research Title: Towards Energy Efficient Mobile Sensing

Research Summary:

Mobile device based urban sensing, participatory sensing, and user activity recognition provide rich contextual information for mobile applications such as social networking and location based services. However, the continuous functioning of these mobile applications is strongly restricted by the limited amount of battery capacity on mobile devices. Yi's Ph.D. research focuses on developing efficient sensing algorithms for energy-constrained systems, aiming at achieving automatic and accurate user state recognition and estimation. In particular, Yi has designed a framework for Energy Efficient Mobile Sensing System (EEMSS) that uses hierarchical sensor management strategy to recognize user states (motion/location/proximity) as well as to detect state transitions. While EEMSS significantly outperforms the state-of-the-art system, Yi further investigated sensing policy optimization in order to achieve the best trade-off between energy consumption and state estimation accuracy for Markov and semi-Markov user state processes respectively. The benchmark empirical results demonstrate that both the Markov-optimal and the semi-Markov optimal sensing policy achieve great performance improvement over the traditional uniform sampling method.

Reference:

Y. Wang, B. Krishnamachari, Q. Zhao, and M. Annavaram. Markov-optimal sensing policy for user state estimation in mobile devices. In IPSN, 2010

PHOTONICS

Name: Eric Jaquay

Email: jaquay@usc.edu

Website: http://www.usc.edu/nanophotonics

Advisor: Michelle Povinelli

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Reconfigurable Photonic Crystal Add/Drop Filters

Research Summary:

Photonic crystals are class of devices which offer great promise in a variety of fields including communications, biomedical engineering, solar energy and many others. My research focuses on communications applications. Currently, most data is transmitted over long distances in the form of light, but it must be converted into an electronic signal for routing, then back into an optical signal to be sent onward again. This conversion is inefficient in terms of both power and speed. The devices which I'm studying could allow us to bypass this conversion by doing the routing optically, thus reducing power requirements while increasing bandwidth. These devices, called photonic crystal add/drop filters, may also find use as interconnects between processors in a multi-processor computer. My work involves three phases:

1 – simulations using software that solves Maxwell's equations which govern electromagnetic phenomena

2 – fabrication of the devices using electron beam lithography and etching in USC's clean room

3 – characterization of the devices in the Povinelli group laboratory in Vivian Hall

Name: Yoo Seung Lee

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Advisor: W. H. Steier

PhD Start Date: Fall 2007

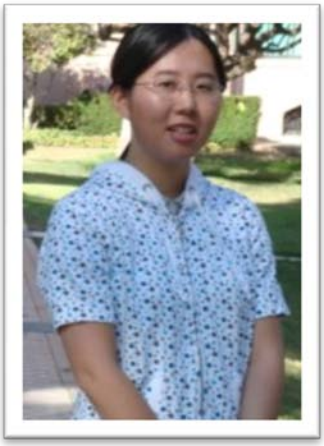
Estimated Graduation: Summer 2011

Research Summary:

Si nano-photonics are being widely investigated since they enable compact photonic integrated circuits with tight optical confinement and well-developed fabrication technology. However, Si lacks no second order nonlinear optical (NLO) effect and the modulators have relied on the plasma dispersion effect which has limited the modulation speeds to ~10 GHz. During Yoo Seung Lee's Ph.D. research, his work addresses new ultra fast (over 40 Ghz) electro-optic device platforms and their applications using single crystal $LiNbO_3$ ultra thin films (~1 μm) and silicon nano-photonics for compact size photonic integrated circuits, optical networks and optical interconnects. It is divided into two parts: the fabrication of active electro-optic device platforms and the integrations of active electro-optic devices based on these platforms. In the first part, the new fabrication technologies of single crystal $LiNbO_3$ films, free standing $LiNbO_3$ micro-platelets, and hybrid Si-$LiNbO_3$ device platforms were demonstrated and discussed. The second part of his work discusses simulation and experimental work for electro-optically tunable waveguide, micro-ring resonator modulators and photonic bandgap crystal slab waveguides based on hybrid Si-$LiNbO_3$ electro-optic device platforms. Yoo Seung Lee has published 6 journal papers and 12 conference papers.

Reference:

Y. S. Lee et al., "Hybrid Si-$LiNbO_3$ microring electro-optically tunable resonators for active photonic devices," *Optics Letters*, Vol. 36, 1119-1121, (2011)



Name: Yinying Xiao Li

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Website: http://www-scf.usc.edu/~yxiaoli/

Advisor: John O'Brien

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: Semiconductor photonics: Terahertz source and detector

Research Summary:

Yinying is engaged in research on devices at the nanometer scale in photonics and opto-electronics. Her research work is mainly concentrated in design, simulation, fabrication and testing of novel photonic devices, such as, silicon-on-insulator waveguides, photonic crystal and plasmonic waveguides and lasers, and infrared and terahertz sources and detectors. It is recently intended to realize 3~4 terahertz emission and detection by engineering semiconductor inverse quantum dot systems and making use of the subband transitions. In the cleanroom lab, the routine work involves e-beam lithography, dry and/or wet etching during the fabrication of photonic devices. Afterwards, characterization with SEM or FESEM and optical testing of the fabricated devices are carried out. A great part of the work is computational. Large scale simulations are carried out mainly with parallel supercomputers, and programs are routinely worked out in FORTRAN, C, and MATLAB, etc. Apart from computations with supercomputers, other parts of the simulations are carried out with various commercial programs. For finite-element simulations, work is carried out with COMSOL for FEM calculations, LUMERICAL and OPTIWAVE for FDTD. In addition, usual optical and electronic design tools, such as, CODE V and MULTISIM are performed from time to time.

Reference:

Y. Xiao-Li, "Light guiding in a slot waveguide that includes an additional confining core region," Opt. Express 18, 6408-6416 (2010).

Name: Chenxi Lin

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Website: www.usc.edu/nanophotonics

Advisor: Michelle L. Povinelli

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: Optical modelling of nanostructured thin film solar cells

Research Summary:

My research focuses on optical modeling of micro-photonic devices for solar energy conversion using computational electromagnetic methods, such as TMM (transfer matrix method) and FDTD (finite-difference time domain). In particular, I am interested in how sub-micron scale patterning can enhance the light trapping capability and hence increase the optical absorption, and finally the power conversion efficiency of thin film solar cells. The vertically-aligned silicon nanowire array, a promising building block for nanostructure solar cells, was chosen to be the model system of our study. It was found that silicon nanowire arrays with the optimal structural parameters (lattice constant and diameter) can have larger integrated absorption across the solar spectrum than a silicon thin film of equal thickness, even a thin film with an optimal antireflective coating. This work was published in Optics Express. In addition, we investigated the effect of metallic catalyst caps on the optical absorption in silicon nanowire arrays and found that the metal caps degrade the integrated absorption (the results were published in Applied Physics Letters). Finally, we found that certain aperiodic silicon nanowire structures can significantly outperform their periodic counterparts. We demonstrated an optimal design procedure for such aperiodic system using a random walk algorithm. .

Reference:

Chenxi Lin and Michelle L. Povinelli, "Optical absorption enhancement in silicon nanowire arrays with a large lattice constant for photovoltaic applications," Optics Express 17, 19371-19381 (2009)

Name: Name: Jing (Maggie) Ma

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Website: N/A

Advisor: Prof. Michelle Povinelli

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Applications of Optical Forces in Microphotonic Devices

Research Summary:

In the last few years, intense research has been carried out on optical forces induced by the strongly enhanced gradient of the electromagnetic field close to micro- and nanophotonic devices. The forces provide a way to reconfigure microphotonic elements with experimentally measurable deflection. Jing Ma's PhD research focuses on studying the optomechanical force in various micro-photonic devices and exploring potential device functionalities enabled by this relatively new mechanical actuation. Jing Ma has proposed the use of optical forces to achieve highly tunable birefringence in a coupled waveguide system, which may be used as polarization conversion in optical communication systems. Jing Ma has studied an effective Kerr effect induced by this optomechanical phenomenon and explored how microphotonic devices can be designed to tailor the value and sign of the mechanical Kerr coefficient, yielding "customizable" nonlinear materials. Jing Ma has presented an idea that introducing a periodic pattern into the waveguide to form a one-dimensional periodic photonic crystal should introduce additional flexibility in tuning the behavior of the optical force and suggested that the force behavior near the photonic band edge should enable the design of power limiters.

Reference:

J. Ma and M. L. Povinelli, Effect of periodicity on optical forces between a one-dimensional periodic photonic crystal waveguide and an underlying substrate, Appl. Phys. Lett., 97: 151102 (2010).

Name: Hari Mahalingam

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Website: http://polymerphotonics.usc.edu

Advisor: William H. Steier

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2012

Research Title: Design and fabrication of optical coupling waveguides for all dielectric photonic receivers

Research Summary:

There is a need for coupling waveguides made from materials other than the conventional silica based optical fiber for high-Q factor optical resonators (micro-ring, microdisk, toroids) which are made from materials like CaF2, LiNbO3, LiTaO3 etc. The waveguides have to be low loss, cheap and easy to fabricate at the same time have to match the effective refractive index of the optical mode in the resonator. Hari Mahalingam's Ph.D. research focuses on design and fabrication of optical coupling waveguides using various materials to couple light at communication wavelengths to these resonators which are at the core of an all dielectric photonic receiver. In case of the high index LiNbO3, LiTaO3 resonators he has used silica – titania hybrid solgel to obtain refractive index control from 1.4 to 2.4 at a wavelength of 1.55 µm. He has overcome the thermal mismatch of these films coated on silicon substrates by using vacuum based baking techniques. Polymers come in handy in case of the low index CaF2 resonators. By using a combination of Cytop/Teflon and UV15LV polymer materials he is fabricating waveguides with effective indices ~ 1.4. Hari is a co-author on two papers one of which appeared in the IEEE Sensors journal.

Reference:

Bipin Bhola, Pavel Nosovitskiy, Hari Mahalingam and William H. Steier, "Sol-gel based integrated optical microring resonator humidity sensor", IEEE Sensors Journal, Vol.9, No.7, 740-747, July 2009

Name: Lawrence Stewart

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Website: http://www.csl.usc.edu

Advisor: P. D. Dapkus

PhD Start Date: Fall 2004

Estimated Graduation: Summer 2011

Research Title: Tunable Microdisk and Microring Resonators in Compound Semiconductors and Silicon

Research Summary:

Free carrier injection or depletion is widely used as the tuning method for high speed optical modulators, but these devices are ultimately limited by free carrier induced absorption effects. One project focused on the selective oxidation of AlGaAs layers to create a GaAs based high confinement bus waveguide that also allowed for current shaping in order to reduce carrier absorption losses. The mature processing technology and transparency of silicon at communications wavelengths makes it a promising choice for photonic devices; however, silicon suffers from few and comparatively weak tuning methods. While a much slower process than free carrier depletion, thermal tuning allows for large refractive index changes with minimal changes in optical absorption. Lawrence's took advantage of this with a thermally tunable silicon-on-insulator wavelength selective reflector. This device is a widely tunable mirror that could be used in a hybrid laser application and is based on two mutually coupled microring resonators. Lawrence's research interests are mainly experimental and have focused on the development of tunable microrddisk and microring resonator devices in compound semiconductors and silicon.

Reference:

L.S. Stewart and P. D. Dapkus, "In-Plane Thermally Tuned Silicon-on-Insulator Wavelength Selective Reflector," IEEE Photonics WTM, January 2011, paper MC3.4.

Name: Xiaoxia Wu

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Advisor: Alan E. Willner

PhD Start Date: Fall 2006

Estimated Graduation: TBD

Research Title: High-Speed Optical Signal Processing towards Tbit/s Optical Networks

Research Summary:

Optical fiber communication systems are characterized by their extremely high transmission capacity. Future optical networks will likely require ultra-fast operations that are able to reduce the latency at nodes as well as to increase the available bandwidth, without affecting the traffic performance. Optical signal processing overcomes the electronic bandwidth limitations with the advantages in terms of transparency and scalability. The conducted research work is aimed at the realization of a few key signal processing subsystems for high-speed optical signal. By exploiting nonlinear effects in highly nonlinear fiber and periodically poled lithium niobate waveguide, we demonstrate optical signal processing subsystems include an optical parametric delay at a bit rate of 160-Gbit/s, a pseudo-random bit sequence multiplexer with tunable order and rate up to 171.2-Gbit/s, a 40-to-640-Gbit/s multiplexer, a 640-Gbit/s reconfigurable demultiplexer, multiple optical logic gates operating at 160-Gbit/s and 640-Gbit/s, a wavelength convertor for orthogonal-frequency-division-multiplexing signal, etc. Other research projects include optical performance monitoring, optical generation of ultra-wideband signal, etc.

Reference:

Xiaoxia Wu, Jeffrey Jargon, Ronald A. Skoog, Loukas Paraschis, and Alan Willner, “Applications of Artificial Neural Networks in Optical Performance Monitoring,” IEEE/OSA Journal of Lightwave Technology, vol. 27, no. 16, pp. 3580-3589, Aug. 2009.

Name: Omer Faruk Yilmaz

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Advisor: Alan E. Willner

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2011

Research Title: Advanced nonlinear optical signal processing techniques for high-speed, reconfigurable optical fiber networks

Research Summary:

Optical fiber telecommunications is facing the bottleneck of electronics due to the increasing demand for higher bandwidth by the consumers. The limited speed of state-of-the-art electronics and inefficient optical-electrical-optical conversions has encouraged the researchers in the photonics society to look for alternatives to electronics and electronic signal processing. Optics offer very high bandwidths (>Terahertz) for data transmission and ultra-fast response (a few tens of femtoseconds) for signal processing applications. In my work, we bring a systematical development to the nonlinear optical signal processing methods enabling complex signal processing functionalities. We show that optical signal processing can be used for achieving system level applications such as buffering, and time-slot interchange of packets, correlation, equalization, and matched filtering enabled by coherent optical multicasting and multiplexing techniques along with tunable optical delays. Each of these consists of sub-systems that need improvements to form a complete, utilizable functional block for optical communications. We present novel solutions to these problems and develop systems with improved metrics. Record reconfiguration times (as low as 25 ps – 1 bit time at 40 Gbit/s) of such functionalities is demonstrated.

Reference:

Yilmaz, O.F.; Nuccio, S.R.; Xiaoxia Wu; Willner, A.E.; , "40-Gb/s Optical Packet Buffer Using Conversion/Dispersion-Based Delays," IEEE/OSA Journal of Lightwave Technology, vol.28, no.4, pp.616-623, Feb.15, 2010

Signal Processing

Name: Anas Al Majali

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Advisor: Clifford Neuman

PhD Start Date: Spring 2009

Estimated Graduation: Fall 2013

Research Title: Smart Grid Security

Research Summary:

Smart Grids are widely spread distributed systems that used to have their own private proprietary networks, protocols and devices. However, the Smart Grid controlling the power grid started utilizing public networks and standard protocols in order to enhance services provided (e.g. home automation) and reduce the cost of deployment. This new modernized Smart Grid is facing new cyber security challenges that might affect human safety, Smart Grid reliability and customer privacy. Anas Al Majali Ph. D. research focuses on designing a Smart Grid where security is taken into consideration as part of the system architecture. To achieve this goal, Anas is currently working on modeling and simulating the Smart Grid on DETER testbed at the Information Science Institute (ISI). By modeling and simulating the Smart Grid on DETER, researchers will be able to know what attack scenarios can achieve any kind of service disruption. Assessing the vulnerabilities of the Smart Grid can be done by determining the components that can be compromised to penetrate the system then constructing attack trees to assess the vulnerabilities of those components. After modeling and simulating the system, a Smart Grid that takes security into consideration as part of system architecture can be built.

Name: Syed Ashrafulla

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Advisor: Richard Leahy

PhD Start Date: Fall 2006

Estimated Graduation: Spring 2012

Research Title: Identifying Mixed Brain Processes via MEG

Research Summary:

We want to identify the many functional processes that make up brain activity. With magnetoencephalography (MEG), we have a highly-sampled non-invasive measurement of brain activity – whose electrical currents generate measurable magnetic fields outside the head. However, these measurements are weighted sums of the brain activity from these processes. Our goal is to identify these functional processes amidst such mixing and lack of anatomical knowledge of each process.

First, we verified whether we could apply standard MEG analysis to data from multiple centers without errors in inference. We tested whether the variability in MEG data across centers is more than the variability in MEG data for multiple sessions. We showed that, under certain conditions of regularity, pooling multicenter MEG data did not appreciably decrease the localization of cortical activity.

We next plan to identify processes modeled as multivariate autoregressive sources, tying together process interaction and source dependence on past values. We model MEG signals as mixtures of all source activity in the brain, with mixing parameters unknown. Our goals are two-fold: determine the causal relationships between brain regions in a given process, and find all such processes amidst MEG signals.

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Advisor: Shrikanth S. Narayanan

PhD Start Date: Fall 2008

Estimated Graduation: Summer 2013

Research Title: Computational framework for learning and analysis of multi-perspective data

Research Summary:

Conventional supervised pattern recognition assumes the availability of gold standard features and labels. Real-world data is just the opposite. The label vocabulary is defined in an ad-hoc fashion and the label assignment process is inherently subjective. The question of what features to use is also heavily debated among experts. The widespread practice has been to convert this multi-perspective data into a single perspective before applying standard pattern classification techniques. For example, multiple labels for a training instance are fused into one based on plurality voting. Feature sets are also trimmed and transformed based on some systemic performance metric. While this conversion to pseudo gold standard features/labels enables the use of off-the-shelf learning algorithms, it loses the rich variability inherent in the multi-perspective data. My current research interest is in developing learning algorithms which take all the available perspectives of labels and features into account. I am also interested in quantifying the gain in using multi-perspective instead of single perspective data. As a first step, I am looking at problems where both the training and test data have multiple labels assigned by a committee of diverse experts. Application areas include emotion recognition, speech processing, behavioral and multi-modal signal processing.

Reference:

Kartik Audhkhasi and Shrikanth S. Narayanan, “Data-dependent evaluator modeling and its application to emotional valence classification from speech”, Proc. InterSpeech, 2010, pp. 2366-2369.

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Advisor: Richard Leahy

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2013

Research Title: Partial Phase Locking Value for Multidimensional Circular Gaussian Model

Research Summary:

Of recent importance in cognitive science is understanding the neural synchronies in human brain. For this purpose, phase locking value is one of the most common measures for detecting time-locked relationships in dynamic recordings of brain activity. However, in practice, it is ambiguous whether phase locking value measures direct or indirect relationships between signals. As a bivariate measure, phase locking value cannot reveal the phase relationship between two signals independent from each signal's relationship with other signals. We are interested in exploring the direct relationship between two signals by measuring the partial phase locking value. In addition, most previous studies ignored the effect of amplitude on estimation of phase synchronization. We developed a multidimensional circular Gaussian model to measure partial phase locking value. We show that amplitude and phase are not independent under Gaussianity assumptions. By using properties of the multivariate Gaussian random variable, we explore partial phase locking values for recordings of brain cortical activity.

Name: Matthew P. Black

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Advisor: Shrikanth S. Narayanan

PhD Start Date: Fall 2005

Estimated Graduation: Summer 2011

Research Title: Automatic Quantification and Prediction of Human Subjective Judgments in Behavioral Signal Processing

Research Summary:

Human judgments on human behavior are an important part of interpersonal interactions and many assessment and intervention designs. While humans have evolved to be naturally adept at processing behavioral information, there are some challenges caused by the qualitative and subjective nature of the judgment process. Matthew Black's Ph.D. research is in behavioral signal processing, specifically on the automatic quantification and emulation of human observational processes to describe human behavior. Highlights of this work include: predicting children's reading ability as accurately as human evaluators by extracting human-inspired cues and modeling multiple evaluators' perceptions, and automatically classifying relevant high-level behaviors during real interactions of married couples by fusing automatically derived speech and language information. He is currently leading an interdisciplinary effort with collaborators at the USC Keck School of Medicine to collect and analyze a large corpus of social interactions between expert psychologists and children diagnosed with autism spectrum disorders. Matthew has published journal papers in *IEEE Transactions on Audio, Speech, and Language Processing* and *ACM Transactions on Speech and Language Processing*. He has authored or co-authored over 15 papers in refereed conferences and workshops. His work was awarded the Best Paper Award by the *International Speech Communication Association* in 2010.

Reference:

Matthew P. Black, Joseph Tepperman, and Shrikanth S. Narayanan, Automatic prediction of children's reading ability for high-level literacy assessment, *IEEE Transactions on Audio, Speech, and Language Processing*, Accepted September 2010, In Press.

Name: Daniel Bone

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Advisor: Shrikanth Narayanan

PhD Start Date: Fall 2009

Estimated Graduation: TBD

Research Title: Intoxicated Speech Detection

Research Summary:

This research was conducted for submission to the Interspeech 2011 Speaker State Challenge.

Speaker state recognition is a challenging problem due to speaker and context variability. Intoxication detection is an important area of paralinguistic speech research with potential real-world applications. In this work, we build upon a base set of various static acoustic features by proposing the combination of several different methods for this learning task. The methods include extracting hierarchical acoustic features, performing iterative speaker normalization, and using a set of GMM supervectors. We obtain an optimal unweighted recall for intoxication recognition using score-level fusion of these subsystems. Unweighted average recall performance is 70.54% on the test set, an improvement of 4.64% absolute (7.04% relative) over the baseline model accuracy of 65.9%.

Reference:

Daniel Bone, Matt Black, Ming Li, Angeliki Metallinou, Sungbok Lee, Shrikanth Narayanan, “Intoxicated Speech Detection Using Hierarchical Features and Iterative Speaker Normalization,” submitted to Proc. Interspeech, 2011.

Name: Erik Bresch

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Advisor: Shri Narayanan

PhD Start Date: Fall 2003

Estimated Graduation: Spring 2011

Research Title: Visualizing and Modeling Vocal Production Dynamics

Research Summary: Understanding human speech production is of fundamental importance for basic and applied research in human communication: from speech science and linguistics to clinical and engineering development. While the vocal tract posture and movement can be investigated using a host of techniques, the newly developed real-time (RT) magnetic resonance imaging (MRI) technology has a particular advantage - it produces complete views of the entire *moving* vocal tract including the pharyngeal structures in a non-invasive manner. RT-MRI promises a new means for visualizing and quantifying the spatio-temporal articulatory details of speech production and it also allows for exploring novel data-intensive, machine learning based computational approaches to speech production modeling.

The central goal of my research is to develop new technological capabilities and to use these novel tools for studying human vocal tract shaping during speech production. My research, which is inherently interdisciplinary, combines *technological* elements (to design engineering methods and systems to acquire and process novel speech production data), *experimental* elements (to design linguistically meaningful studies to gather useful insights) and *computational* elements (to explain the observed data and design predictive capabilities).

Reference: E. Bresch, Y. C. Kim, K. Nayak, D. Byrd, and S. Narayanan, "Seeing speech: Capturing vocal tract shaping using real-time magnetic resonance imaging," *IEEE Signal Processing Magazine*, vol. 25, no. 3, pp.123-132, May 2008.

Name: SangHyun Chang

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Supervisor: Hossein Hashemi

Ph.D. Advisor: Robert A. Scholtz

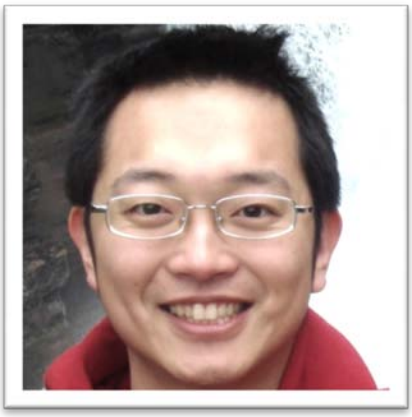
Postdoc Start Date: Spring 2009

Research Summary:

My research has been primarily focused on developing Ultra-Wideband (UWB) radar and radio systems. Compared with computer vision, LADAR, and infrared imagers, UWB radar can provide a complementary technology for detecting and tracking humans, particularly in poor visibility or through-wall conditions, as well as in low power consumption. My research interests include UWB radar-based human detection and tracking, collaborative human and environment sensing, Simultaneous Localization And Mapping (SLAM), multi-modal sensing (radar, stereo-camera, and LADAR), communication theory, and joint radar sensing and communications.

Reference:

S. Chang, et al., “Tracking multiple humans using UWB radar: a multiple-hypothesis cluster tracking approach,” submitted to IEEE Transaction on Signal Processing



Name: Yu-Teng Chang

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Advisor: Richard Leahy

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2011

Research Title: Modular Graph Partitioning: Statistical Null Models and Applications

Research Summary:

Graph partitioning methods based on modularity are designed to preserve and detect the underlying structures in the network through partitioning. They rely heavily on the null model, in which there are no community structures but conditioned to have the same number of nodes, edges, and degree sequence as the original graphs. Yu-Teng Chang's research focuses on developing statistical null models used in different conditions, either directed or undirected, and under different graph edge distributions, such as Bernoulli random networks, Gaussian random networks, etc. The method for information flow in networks under unified framework is also proposed. Applications on brain neural networks, social networks, and gene networks are studied. In addition to the application side, more other theoretical properties are also investigated, including significance of the structure and limitation of the detection resolution, and the remedy to this limitation.

Reference:

Y Chang, D Pantazis, H.B. Hui, R.M. Leahy, (2010), "Statistically optimal graph partition method based on modularity", Proc. IEEE Int Symp. Biomed Imag, pp. 1193–1196, April, 2010.

Name: Seongho (Steve) Cho

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Advisor: C.-C. Jay Kuo

PhD Start Date: Fall 2007

Estimated Graduation: Fall 2011

Research Title: Block-Based Image Steganalysis

Research Summary:

Block-Based Image Steganalysis: Traditional image steganalysis techniques are conducted with respect to the entire image. In this work, we aim to differentiate a stego image from its cover image based on steganalysis results of decomposed image blocks. As a natural image often consists of heterogeneous regions, its decomposition will lead to smaller image blocks, each of which is more homogeneous. We classify these image blocks into multiple classes and find a classifier for each class to decide whether a block is from a cover or stego image. Then, the steganalysis of the whole image is conducted by fusing decision results of all image blocks through a voting process. Furthermore, the performance of block-based image steganalysis in terms of block sizes and block numbers is examined. We show that a larger block size and a larger block number will result in better performance. For a given test image, there exists a trade-off between the block size and the block number. To achieve better detection accuracy, we propose to use overlapping blocks to increase the block number. Experimental results will be given to show the advantage of the proposed block-based image steganalysis approach.

Reference:

Seongho Cho, Byung-Ho Cha, Jingwei Wang and C.-C. Jay Kuo, " Performance Study on Block-Based Image Steganalysis", in *Proc. IEEE International Symposium on Circuits and Systems, Special Session on Digital Forensics*, Rio de Janeiro, Brazil, May 2011.

Name: Zihong Fan

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Advisor: Antonio Ortega

PhD Start Date: Fall 2005

Estimated Graduation: Summer 2011

Research Title: Interactive Fast Random Access, Retrieval, and Navigation of Large Datasets

Research Summary:

Zihong Fan's PhD research¬ work¬ is motivated by two important trends. First, more than ever before large amounts of data and information are being accessed through mobile devices such as smart phones, tablet computers, book readers, etc. Second, significant amounts of complex and high-volume information (e.g. maps, medical images, scientific datasets, virtual museums, etc.) are now available over networks. In addition to entertainment applications (e.g. video sharing), a significant driver of traffic over networks is likely to come from professional applications. Such applications, like ones that might provide doctors pervasive access to medical information, would demand high quality performance according to a variety of different metrics, such as latency, resolution, interactivity, and perceptual quality. She has proposed a novel system for interactive, fast, and random access and navigation of large datasets. Of particular interest in the proposed system is the random retrieval of lower dimensional data from high dimensional datasets. The system makes it possible to allow limited-memory mobile devices to quickly access complex large datasets over low-bandwidth connections. By this approach, the transmission rate reduce dramatically and also improve the level of interactive navigation. She has developed both 2D and 3D systems for fast, random access and each system is composed of a tiling scheme, linear searching algorithm, compression methodology, mapping algorithm, and reconstruction scheme. The mapping algorithms can also be applied to various other applications and areas. Her work offers both theoretical and practical contributions and can be used in a wide-array of exciting future applications. In addition to research publications and invited talks to Microsoft Research Asia, Google at Mountain View and Google research in China, one application proposal was also selected as a finalist in the Qualcomm Innovation Competition (2010).

Reference:

Zihong Fan, Antonio Ortega, "Optimization of Overlapped Tiling for Efficient 3D Image Retrieval" full paper in Proc of IEEE Data Compression Conference (DCC), Mar. 2010.

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Advisor: Shrikanth S. Narayanan

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2011

Research Title: A computational framework for exploring the role of speech production in speech processing from a communication system perspective

Research Summary: The theme of my phd research work is to develop a computational framework for deriving articulatory data driven features from talker's speech for improving speech recognition accuracy. Direct articulatory measurement from the talker during recognition is not realistic in practice. The proposed computational framework estimates the articulatory features from talker's speech using speech production knowledge (i.e., articulatory-acoustic map) of only one exemplary subject. Thus, the proposed framework makes such articulatory data driven speech recognition realistic in practice. Theoretical analysis reveals that the estimated articulatory features have the potential to improve upon acoustic-only speech recognition. Phonetic recognition experiment on TIMIT corpus shows that the recognition accuracy improves by ~4% (absolute) when estimated articulatory features are used in addition to acoustic speech features.

Reference:

Prasanta Ghosh and Shrikanth Narayanan, “A subject-independent acoustic-to-articulatory inversion”, accepted in ICASSP, Prague, Czech Republic, 2011.

Name: Dian Gong

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Advisor: Gérard Medioni

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2012

Research Title: Robust Local to Global Structure Learning on Multiple Manifolds

Research Summary:

Dian's PhD research investigates a fundamental issue in machine learning and computer vision: learning the manifold structure for high dimensional data corrupted by noise, in the presence of outliers. Our primary goal is to accurately estimate the local intrinsic dimensionality and tangent space, and then infer the underlying global manifold structure for the input data.

Tensor Voting is a non-parametric approach to infer the data structure with explicit consideration of outliers. However, both outlier and inlier noise commonly occur in many areas in computer vision. By taking the uncertainty of data into consideration, the proposed Probabilistic Tensor Voting can handle both inlier noise and outliers with a combined geometric and probabilistic framework. Furthermore, the computational framework of voting is extended to N-D space for multiple manifolds learning. The vote, i.e., the geometric information propagated from one point to its neighborhood, is represented in a closed-form formulation involving eigen-decomposition with elegant mathematical interpretation. Based on local structure estimations, global structure learning, i.e., clustering, alignment and denoising are effectively done with the proposed local to global association approach. Dian's work has been applied to real problems in computer vision including, motion data alignment, temporal segmentation, action recognition, images denoising and contour grouping.

Reference:

Dian Gong, Fei Sha, and Gérard Medioni, "Locally Linear Denoising on Image Manifolds", Proc. of the 13th International Conference on Artificial Intelligence and Statistics (AISTATS), Sardinia, Italy, May 2010. Volume 9 of Journal of Machine Learning Research: W&CP 9

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Advisor: Gaurav S. Sukhatme

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Obstacle Detection, Avoidance and Prediction for Autonomous Surface Vehicles using a Profiling Sonar

Research Summary:

Autonomous surface vehicles (ASVs) are useful for a variety of tasks in lake and harbor environments e.g. environmental monitoring, recovery, and environmental cleanup. An autonomous vehicle needs to be able to plan safe and efficient paths through an environment with obstacles. For dynamic obstacles, the vehicle needs to be able to sense its surroundings and react appropriately. We propose using an underwater sonar in forward pointing configuration in order to detect obstacles in the environment.

Static obstacles can be planned around using a map of the environment. Unfortunately, maps do not exist for all environments and may be time consuming to make and update. Also, map items may not be obstacles significant to all types of vehicles. One way to satisfy the need for a current obstacle map is to automatically build one from a recent aerial or satellite image of the operating area using classification techniques to estimate obstacle locations. Such an approach needs labeled training data and thus requires human labor. We propose using the forward facing sonar to generate labels locally around the vehicle and then use them in conjunction with aerial imagery to predict obstacles in the environment.

Reference:

Hordur K. Heidarsson and Gaurav S. Sukhatme. "Obstacle Detection and Avoidance for an Autonomous Surface Vehicle using a Profiling Sonar". To appear in IEEE International Conference on Robotics and Automation (ICRA), Shanghai, China, May 2011.

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Advisor: Antonio Ortega

PhD Start Date: Fall 2006

Estimated Graduation: Summer 2011

Research Title: 3-D Video Coding System with Enhanced Rendered View Quality

Research Summary:

The objective of this research is to develop a new 3-D video coding system which can provide better coding efficiency with improved subjective quality as compared to existing 3-D video systems such as the depth image based rendering (DIBR) system. As a starting point, the distortion occurred in the 3-D video system is analyzed to find the localized and non-linear features of the distortion. Based on this, the new methods to estimate the rendered view distortion from the depth map quantization error are proposed, first by calculating the geometry error caused by the depth map error using the camera parameters, then estimating the rendered view distortion based on the local video characteristics. Experimental results show the efficiency of the proposed method with coding gains of up to 1.6 dB. Secondly, we propose a new 3-D video format in which *depth transition data* is encoded and transmitted to the decoder. Depth transition data for a given pixel indicates the camera position for which this pixel's depth will change. Given the highly localized and non-linear characteristics of rendered view distortion, it is possible to achieve better coding performance by providing this depth transition data only for subjectively important regions. Experimental results verify that improvements in subjective quality can be achieved by the proposed method with maximum PSNR gain of 2 dB.

Reference:

W.-S. Kim, A. Ortega, J. Lee, and H. Wey, "3-D video coding using depth transition data," in Proc. of 28th Picture Coding Symposium (PCS '10), Nagoya, Japan, Dec. 2010.

Name: Jangwon Kim

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Advisor: Shrikanth Narayanan

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2014

Research Title: An exploratory study of manifolds of emotional speech

Research Summary:

Jangwon Kim's Ph.D. research focuses on emotional speech production, including emotional speech space representation. In this study, he investigated the manifold representations of emotionally modulated speech in both the acoustic and articulatory domains. The manifolds are derived in the articulatory space and two acoustic spaces (MFB and MFCC) using isometric feature mapping (Isomap) with data from an emotional speech corpus. Their effectiveness in representing emotional speech is tested based on the emotion classification accuracy. Results show that the effective manifold dimensions of the articulatory and MFB spaces are both about 5 while being greater in MFCC space. Also, the accuracies in the articulatory and MFB manifolds are close to those in the original spaces, but this is not the case for the MFCC. It is speculated that the manifold in the MFCC space is less structured, or more distorted, than others. He has published three conference papers in emotional speech production areas.

Reference:

Jangwon Kim, Sungbok Lee and Shrikanth S. Narayanan, *"An exploratory study of manifolds of emotional speech"*, in Proceedings of the International Conference on Acoustics, Speech, and Signal Processing (ICASSP), 2010

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Adviser: Jerry M. Mendel

PhD Start Date: Spring 2010

Estimated Graduation: Fall 2014

Research Title: Perceptual Computing: Aiding People in Making Subjective Judgments

Research Summary:

My current project objective is to apply existing computing with words techniques (novel weighted averages, linguistic summarization, perceptual reasoning, etc.) or develop new ones to generate rules/patterns from data or to summarize the data so that data can be transformed into knowledge.

I am working on a methodology called Fuzzy Set Qualitative Comparative Analysis (fsQCA) which can be used for obtaining linguistic summarizations from data that are associated with cases. FsQCA seeks to establish logical connections between combinations of causal conditions and a desired outcome. It can also be viewed as a methodology for establishing causality, not of a single causal condition but of combinations of such causal conditions. FsQCA c available information from numbers to words; therefore, aids people in making subjective judgments.

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Advisor: Antonio Ortega

PhD Start Date: Fall 2007

Estimated Graduation: Fall 2011

Research Title: Wavelet Transforms for Graph based Unstructured Data

Research Summary:

My work is focused on constructing linear wavelet-like transforms of functions defined on the vertices of an arbitrary finite weighted graph. These functions are called 'graph-signals' and the examples of such datasets include i) blogs, where the graph is defined by links between blog entries, ii) social networks, e.g., twitter, where follower/followee relationships can be used to define the graph, or iii) more traditional datasets for which geographical information can be used to induce some distance between nodes. Major challenges are posed by the size of these datasets, making it difficult to visualize, process, analyze and act on the information available. Wavelets have been popular for traditional signal processing problems (e.g., compression, segmentation, denoising) because they allow signal representations where a variety of trade-offs between spatial (or temporal) resolution and frequency resolution can be achieved. However the special characteristics of graph signals in terms of geometry and uniformity of the graph make straight-forward extensions of wavelet-transforms designed for traditional regularly sampled signals infeasible. Therefore I develop and implement wavelet transforms especially for data defined on graphs. My proposed work will make it possible to develop i) multiresolution representations of graphs, ii) localized estimation of user preferences, and iii) graph-temporal analysis of datasets.

Reference:

S.K. Narang and A. Ortega, "Local Two-Channel Critically Sampled Filter-Banks On Graphs",*Intl. Conf. on Image Proc. (ICIP'10).*

Name: Cheng-Hao Kuo

Email: chenghak@usc.edu

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Advisor: Ram Nevatia

PhD Start Date: Fall 2006

Estimated Graduation: Summer 2011

Research Title: Multi-Target Tracking by On-Line Learned Discriminative Appearance Models

Research Summary:

Cheng-Hao Kuo's research interests include computer vision, pattern recognition, and machine learning. His Ph.D thesis focuses on intra-camera and inter-camera multi-target tracking in a surveillance scenario. Based on the data-association tracking methodology, he proposed a novel approach to on-line learn the discriminative appearance models (OLDAMs) for the tracked targets. The training samples are collected during runtime by spatio-temporal constraints; this allows the models to adapt to target instances. Learning uses an AdaBoost algorithm which combines effective image descriptors and their corresponding similarity measurements. The experimental results on several public datasets show the significant improvements over state-of-the-art methods in terms of tracking evaluation, especially for a crowded environment where the occlusions and interactions between targets happen often. Cheng-Hao has published several papers on top-tier conferences in the area of computer vision, including CVPR 2010, CVPR 2011, and ECCV 2010. He also serves the reviewer of IEEE transactions on Multimedia.

Reference:

Cheng-Hao Kuo, Chang Huang, and Ram Nevatia. “Multi-Target Tracking by On-Line Learned Discriminative Appearance Models.” In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition* (CVPR), San Francisco, CA, June 2010.

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Advisor: Antonio Ortega

PhD Start Date: Fall 2006

Estimated Graduation: Spring 2012

Research Title: Spatially-localized compressed sensing for multi-hop wireless sensor network

Research Summary:

In sensor networks, energy efficient data manipulation / transmission is very important for data gathering, due to significant power constraints on the sensors. As a potential solution, Compressed Sensing (CS) has been proposed, because it requires capturing a smaller number of samples for successful reconstruction of sparse data. He has studied CS approaches for sensor networks that are spatially-localized, thus reducing the cost of data gathering. In particular, He investigated the reconstruction accuracy properties of a new distributed measurement system that constructs measurements within spatially-localized clusters. He first introduced the concept of maximum energy overlap between clusters and basis functions, and showed that the proposed metric can be used to estimate the minimum number of measurements required for accurate reconstruction. Based on this metric, He also proposed a centralized iterative algorithm for joint optimization of the energy overlap and distance between sensors in each cluster. Also, he has been investigating to extend his approach to multi-view video system in order to achieve efficient compression of depth information.

Reference:

S. Lee and A. Ortega "Joint Optimization of Transport Cost and Reconstruction for Spatially-Localized Compressed Sensing in Multi-Hop Sensor Networks ".*In Proceedings of APSIPA Annual Summit and Conference (APSIPA ASC 2010)*, Singapore, December 2010.

Name: Ming Li

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Website: http://www-scf.usc.edu/~mingli/

Advisor: Shrikanth Narayanan

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2012

Research Title: Multimodal human state recognition

Research Summary: My current research is focusing on multimodal human state recognition. Human state includes their identify, their physical activity states, their paralinguistic information (age,gender,et, al), and so on. This kind of information is very useful in real life applications. The main areas that I am currently working on is:

1. Speech signal processing: Speaker verification, spoken language identification, speaker age and gender identification, speaker emotion recognition

2. Multimodal biometrics: Audio-visual joint biometrics, emerging behavior biometrics (ECG biometrics), multimodal fusion

3. Body sensing, processing and modeling methods in metabolic health monitoring: Multimodal physical activity recognition, multimodal emotion recognition, energy efficient sensing and modeling, compressive sensing

My previous research interests:

1. Audio watermarking: Robust frequency domain audio watermarking, content adaptive audio watermarking in wavelet domain

2. Computational acoustics scene analysis: co-channel speech separation

Reference:

Ming Li et al., "Multimodal Physical Activity Recognition by Fusing Temporal and Cepstral Information," *IEEE Transactions on Neural Systems & Rehabilitation Engineering,* vol 18, issue 4, August, 2010.

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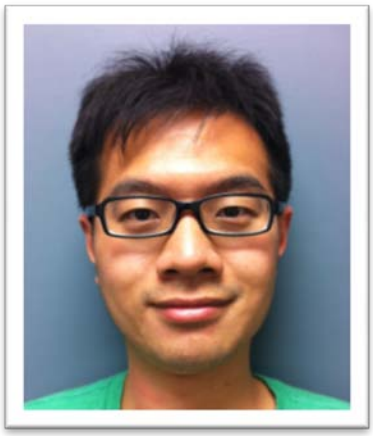
Advisor: Paul Daniel Dapkus

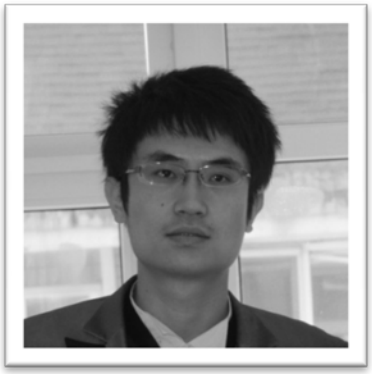


PhD Start Date: Fall 2009

Estimated Graduation: Fall 2014

Research Summary:

Semiconductor nanowires have shown promising electronic and optical properties. However, nanoscale catalysts or lithography processes are required for most of the popular approaches, which are relatively complicated and time-consuming. Recently, a catalyst-free and lithography-free method, based on an in-situ grown SiNx thin layer, is shown to be able to produce nanowires by MOCVD. In this approach, a thin and porous layer of SiNx film, which serves as an effective mask for MOCVD selective area growth, is first deposited on the GaN substrate followed by a GaN nucleation sequence and nanowire growth. This continuous method is extremely simple and can be applied for large area growth of nanowires for application to nanowire LEDs. Nanowire density and uniformity, however, remain a challenge to achieve the desired nanowire characteristics. In this paper, we report a study of the combined effects of SiNx mask formation and nanowire growth conditions on the properties of GaN nanowires grown in this way.



Name: Yanguang Lin

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Advisor: Richard Leahy

PhD Start Date: Fall 2008

Estimated Graduation: Summer 2013

Research Title: PET Image Reconstruction

Research Summary:

Yanguang's research focuses on statistical signal processing with applications on PET (Positron Emission Tomography) image reconstruction. His works range from kinetic parameter estimation of dynamic PET reconstruction to system modeling and optimization method of TOFMAP (Time of Flight Maximum a Posteriori) PET reconstruction. Based on a mixture model approach, his kinetic parameter estimation work can help physicians differentiate tumor and normal tissue. His TOFMAP work can help improve the signal to noise ratio and conditioning of the system in regular PET data by using the TOF information. And with a powerful GPU implementation, he can speed up the PET reconstruction without losing accuracy. Yanguang has published 2 conference papers and has been granted MIC Student Paper Award Nuclear Science Symposium (NSS/MIC), Oct, 2009

Reference:

Y. Lin, Q. Li, R.M. Leahy, (2009), " Kinetic parameters estimation for heterogeneous tumor model", IEEE Nuclear Science Symposium Conference Record (NSS/MIC), Oct, 2009

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Advisor: C.-C. Jay Kuo

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2013

Research Title: Visual Quality Assessment on Multimedia

Research Summary:

Video quality monitoring to maintain Quality of Service (QoS) becomes increasingly critical these days. Methods for evaluating the perceptual quality of videos form an important component in this application. The only reliable method to assess the video quality is to ask human subjects for their opinion, which is known as subjective video quality assessment (VQA). However, subjective VQA is tedious and time-consuming since it has to be performed with great care in order to obtain meaningful results and it is in general not applicable for real-time processing. Hence, objective methods which can automatically assess the quality of a video in an efficient and accurate way are urgently needed. This is referred to as objective VQA. He proposed a new objective video quality metric based on a different perspective. He extended one existing image quality metric to a video quality metric by considering temporal information and converted it into some compensation factor to correct the video quality score obtained in the spatial domain. After experiments, he found out this proposed quality assessment metric did work well in the Laboratory for Image and Video Engineering (LIVE) Video Quality Database and was also competitive with the other existing state-of-the-art video quality metrics.

Reference:

Tsung-Jung Liu, Kuan-Hsien Liu, and Hsin-Hua Liu, “Temporal information assisted video quality metric for multimedia,” Proc. IEEE International Conference on Multimedia & Expo, 2010

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Advisor: C.-C. Jay Kuo

PhD Start Date: Fall 2010

Estimated Graduation: Spring 2013

Research Title: Disparity Estimation for Multiview Videos

Research Summary:

Multiview video is a collection of video sequences which are obtained by using multiple cameras on different positions to capture a scene at the same time instance. It can provide richer viewing experiences than traditional single view video, since a customer can see a scene from multiple viewing directions. As all cameras simultaneously capture the same scene from different viewpoints, multiview video sequences contain a large amount of inter-view similarities between adjacent camera views and temporal similarities between temporally successive images of each video. Exploiting similarities (ie. removing redundancies) among multiview video sequences is the key to make efficient compression. Disparity estimation is crucial to multiview video coding (MVC), which has attracted much attention recently. In the MVC reference software, named JMVM, the global disparity vector (GDV) was estimated by frame matching on spatial neighbor views. A scale invariant feature transform (SIFT) based disparity estimation method is proposed by him to estimate the GDV. The experimental results show that benefits on peak signal-to-noise ratio (PSNR) and saved bits can be obtained by adopting our proposed method compared to the JMVM method that was often used.

Reference:

Kuan-Hsien Liu, Tsung-Jung Liu, and Hsin-Hua Liu, “A SIFT descriptor based method for global disparity vector estimation in multiview video coding,” *Proc. IEEE International Conference on Multimedia & Expo*, 2010

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Advisor: Krishna Nayak

PhD Start Date: Fall 2005

Estimated Graduation: Fall 2011

Research Title: Vessel Wall Imaging

Research Summary:

Atherosclerosis is perhaps the single most deadly disease in the US. Early detection and management of this disease will significantly reduce the fatal incidence rate. The use of Magnetic Resonance Imaging (MRI) modality for study and diagnosis of atherosclerosis in humans has recently gained momentum. MRI is an excellent modality for such assessment since it provides the capability of characterizing plaque composition and lacks ionizing radiation. MRI has the unique capability of non-invasively screening patients for high risk plaque. The use of MRI for Carotid vessel wall imaging (VWI) has been successfully demonstrated However, the standard imaging protocol suffers from long scan times affecting reproducibility of the study and does not provide adequate spatial resolution to image fine plaque components that are precursors of significant disease. Our preliminary results have demonstrated the feasibility of accelerated VWI using compressive sensing (CS) theory. The proposed approach was able to achieve 3.5 acceleration without sacrificing image.

Reference:

Makhijani, M. K., Hu, H. H., Pohost, G. M. and Nayak, K. S. (2010), Improved blood suppression in three-dimensional (3D) fast spin-echo (FSE) vessel wall imaging using a combination of double inversion-recovery (DIR) and diffusion sensitizing gradient (DSG) preparations. Journal of Magnetic Resonance Imaging, 31: 398–405. doi: 10.1002/jmri.22042

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Advisor: Antonio Ortega

PhD Start Date: Fall 2005

Estimated Graduation: Summer 2011

Research Title: Event Based Measurement and Analysis of Internet Network Traffic

Research Summary:

Internet traffic measurement systems are used in numerous network analysis applications such as network tomography, anomaly detection and quality-of-service measuring tools. One significant problem is that typical Internet traffic signals, e.g., packet arrivals, occur as discrete events; however, most Internet traffic analysis techniques convert the event based measurements to a time series representation, to be compatible with standard signal processing techniques (e.g., fast Fourier transform, etc.). Sean McPherson's PhD thesis work seeks to remedy the signal representation issue by designing an alternative representation, called SigVec, which uses the more natural point process representation. To show that SigVec can be effective in Internet traffic analysis Sean derived a detection system, which uses elements of renewal theory to detect low-rate anomalies in Internet traffic. Using renewal theory Sean constructed a thorough analysis of the detection system performance, which is used in the selection of detection system parameters. Additionally, subsampling of measurements is commonly used in Internet network measurement systems to reduce the data storage cost and measurement system complexity. In his work Sean derived a metric which can optimize the operation of subsampling given constraints for a specific analysis application. Finally, since the SigVec signal representation applies in general to any point process signal it is possible to use detection method Sean derived in a wide range of scientific research applications, such as analyzing biological or financial data.

Reference:

S. McPherson and A. Ortega, “Detecting Low-Rate Periodic Events in Internet Traffic using Renewal Theory.” In Proceedings of 2011 IEEE ICASSP, Prague, Czech Republic, May, 2011.

Name: Angeliki Metallinou

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Advisor: Shrikanth Narayanan

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Exploring multimodality and contextual information for recognition and analysis of emotional expression

Research Summary:

Human expressive communication is characterized by a continuous flow of interacting multimodal cues, including facial expression, body language and speech. Understanding and modeling the interplay of these dynamic multimodal streams and the context in which they occur might be of great use for designing affect-sensitive virtual agents and human computer interfaces. My reseach focuses on these aspects using techniqes from multimodal signal processing and statistical machine learning for human-centered applications. In the paper below, we examine the emotional content of bodylanguage cues describing a participant's posture, relative position and movement, and approach/withdraw behaviors during improvised affective dyadic interactions, and show that they reflect changes in the participant's excitement and dominance levels. Moreover, we describe a framework that utilizes a statistical mapping (optimal in the MLE sense) between the observed audiovisual cues and the underlying user state, described by continuous levels of excitement and dominance, in order to track changes of a subject's emotional state across time.

Reference:

Angeliki Metallinou, Athanassios Katsamanis, Yun Wang and Shrikanth Narayanan, Tracking Changes in Continuous Emotion States using Body Language and Prosodic Cues, ICASSP, Prague, Czech Republic, May 2011

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Advisor: Jerry M. Mendel

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Computing with Words

Research Summary:

In this research, we focus on the application of Type-2 Fuzzy Sets to Advanced Computing with Words problems which involve complicated and implicit assignments of linguistic constraints on truth, probability, usuality, possibility, etc. We investigate hierarchical and distributed decision making problems involving such constraints. We try to categorize different types of Computing with Words problems which involve such assignments. Currently, our focus is on the field of fuzzy probabilities, where we try to axiomatize interval type-2 fuzzy probabilities. We are also developing a linguistic Dempster-Shafer theory of evidence, which allows solving Computing with Words problems in which there exists total ignorance on the value of a variable.

Reference:

M. R. Rajati, J. M. Mendel, D. Wu, “Solving Zadeh’s Magnus Challenge Problem on Linguistic Probabilities Using Linguistic Weighted Averages,” *IEEE International Conference on Fuzzy Systems*, Taipei, Taiwan, June 2011

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Advisor: Shrikanth Narayanan

PhD Start Date: Spring 2009

Estimated Graduation: Fall 2012

Research Title: Speech production planning and execution – representation, modeling and re-synthesis.

Research Summary:

My work focuses on understanding and analysis of speech execution using techniques from signal and image processing, linguistics, and statistics in order to make inferences about how different aspects of speech are "planned" by a higher-level cognitive mechanism. I am interested in applying scientific knowledge to interdisciplinary engineering problems and in turn using engineering approaches to drive scientific understanding.

If we view the speech planning and execution mechanism in humans as a control system, we would like to understand the characteristics of the system such as the goals and constraints of the plan and the architecture of the system among others. For this we would need an understanding of how these characteristics are specified or represented in inputs and outputs of the system, i.e., so-called primitive representations. One aspect of my research focuses on extracting and modeling these representations in a data-driven manner and comparing them to knowledge-driven representations from linguistic theory. Another aspect of this work is understanding how goals of speech production such as postural motor control of articulators, pausing behavior and articulatory reduction are manifest for different speaking styles and speakers. A third aspect of my research involves applying this knowledge of speech production to speech synthesis and speech to speech translation technology.

Reference:

Vikram Ramanarayanan, Erik Bresch, Dani Byrd, Louis Goldstein and Shrikanth S. Narayanan (2009), Analysis of pausing behavior in spontaneous speech using real-time magnetic resonance imaging of articulation, in: *Journal of the Acoustical Society of America*, 126:5(EL160-EL165).

Name: Benjamin L. Raskob

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Advisor: Alice Parker

PhD Start Date: Fall 2005

Estimated Graduation: Spring 2012

Research Title: Stereo Vision Using Disparity Phase-Interference

Research Summary: Neuroscience research has provided a wealth of information on binocular neurons in the primary visual cortex. Still, there is much information missing about how these neuronal responses translate to higher-level neural activity and ultimately to true stereo depth perception, where a subject is able to detect and use three-dimensional information from the differences in position between the left and right eyes. Since Gabor-type filters have been used with much success to model binocular neurons, a signal-processing view of computations in the primary visual cortex is highly beneficial.

The contribution of our research is a wavelet-based formulation of binocular complex cell responses that can detect phase interference patterns caused by disparity in stereo images. This model both encompasses and extends the current mechanisms, but has several key advantages and additions.

First, our formulation uses the peak frequencies of binocular neurons o signal disparity, with a structured framework for the contributions of many neurons sensitive to different frequencies. The simultaneous combination of many frequencies adds robustness as well as allows a larger range of disparities to be encoded. Second, our frequency-centric model uses the orientation of frequencies to provide information for higher-level visual processing such as object segmentation.

Reference:

B. L. Raskob and A. C. Parker, “Towards biomimetic stereo vision,” in *Aerospace and Electronics Conference (NAECON), Proceedings of the IEEE 2010 National*, 2010, pp. 379–382. [Online]. Available: http://dx.doi.org/10.1109/NAECON.2010.5712981

Name: Ran Ren

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Advisor: Richard Leahy

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2013

Research Title: Gap-filling problem for 3D PET data

Research Summary:

In many PET scanners, there exist gaps between detector blocks and the data corresponding to lines of response (LORs) involved with the gaps are missing. The missing gap data must be estimated prior to image reconstruction when the sinogram data are rebinned into lower dimensional formats or the filtered backprojection (FBP) is used. Bilinear interpolation or some filters enforcing the data consistency conditions have been used for non-TOF PET data. However, there has not been any study to estimate the gap data for TOF PET. Here we develop a method to estimate the gap data by iteratively applying a bow-tie filter in the Fourier domain. We derive a bow-tie filter that does not require the Fourier transform in the axial direction. Therefore, our method applies to axially truncated 3D TOF PET data. The new method provides better estimates of the gap data than bilinear interpolation and reduces artifacts due to interpolation error.

Reference:

Ran Ren, Quanzheng Li, Sangtae Ahn, Sanghee Cho, and Richard M. Leahy, *" Estimation of Gap Data Using Bow-Tie Filters for 3D Time-of-Flight PET"*, Medical Imaging Conference (MIC), IEEE, November 2010

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Adviser: Krishna Nayak

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Accelerated Water-Fat MRI

Research Summary:

Water-fat imaging techniques are widely used in magnetic resonance imaging (MRI) clinical protocols to separate water and fat. These techniques are relied upon for tumor detection, for the assessment of fatty infiltration in the heart and liver, and for the detection of vertebral fractures. Within this class of techniques, multi-echo methods have emerged as a valuable tool because they can reliably separate the water and fat signals in the presence of magnetic field inhomogeneity. However, the benefit of multi-echo methods comes with a cost of longer scan time. This cost becomes especially critical in cardiac and abdominal imaging because the patient must maintain a breath-hold throughout the scan. Respiratory motion will cause image artifacts that, in turn, will degrade the confidence of diagnoses made from these images.

In this work, we present a novel approach to reduce the scan time of multi-echo methods while still maintaining accurate water-fat separation. The traditional single-voxel model is generalized to instead jointly estimate the water, fat, and field inhomogeneity images. Thus, we are able to exploit the spatial correlations in those images that we hope to recover. We introduce a new scheme to estimate the field inhomogeneity, one that departs from the conventional heuristically-driven region-growing approaches. We demonstrate the potential for a 60% reduction in scan time, which would shorten a difficult 40-second breath-hold to a much more manageable time of 16 seconds.

Reference:

Sharma SD, Hu HH, Nayak KS. Accelerated water-fat imaging using restricted subspace fieldmap estimation. 19th Annual ISMRM Conference, May 2011, Montreal.

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Advisor: Antonio Ortega

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Supervised and Semi-supervised Learning applied to large scale data

Research Summary:

In recent years, there has been a great amount of large data available, which require effective and efficient learning tools. There are challenges to deal with large unlabeled data, missing labels and problems specific to certain applications, such as bioinformatics, document retrieval, image processing, etc. Lingyan Sheng's research focuses on supervised and semi-supervised classification on large scale data. She has developed algorithm BDLDA with treelets applied to gene expression data. The algorithm adopts a new block structure in linear discriminant analysis, and pariwise feature selection as a pre-processing. The algorithm performs supervised classification, which achieves better classification results compared to state-of-art algorithms. She also developed Graph-PSL, which tackles the semi-supervised learning with missing labels. The algorithm is based on spectral graph theory and support vector machine. The algorithm automatically identifies instances in missing classes and performs semi-supervised learning. It has been successfully applied to large scale document and image retrieval. She also developed a pixel predictor in image coding by support vector regression. This research demonstrated how machine learning approach is applied to traditional signal processing area. Our algorithm achieved lower entropy compared with other widely used pixel prediction methods.

Reference:

Lingyan Sheng, Roger Pique-Regi, Shahab Asgharzadeh, Antonio Orega, "Microarray classification using block diagonal linear discriminant analysis with embedded feature selection", in 2009 IEEE International Conference on Acoustics, Speech and Signal Processing, pp.1757-1760

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Advisor: Krishna Nayak

PhD Start Date: Fall 2007

Estimated Graduation: Spring 2012

Research Title: Ultra fine resolution magnetic resonance imaging of the coronary arteries

Research Summary:

Coronary artery imaging is one of the most challenging applications of magnetic resonance imaging (MRI) because of cardiac and respiratory motion and severe field inhomogeneity inside the chest and around the lungs. However, it is also one of the most important applications since it may reveal evidence of cardiovascular disease years or even decades earlier than current methods. The primary aim of Travis Smith's Ph.D. research is to apply advanced signal processing and image reconstruction methods to overcome these challenges and improve effective image resolution in order to provide clinicians with a more accurate measure of coronary artery function. He has developed an outer volume suppression technique to increase resolution and reduce artifacts in spiral imaging. He is currently working on nonlinear and model-based deblurring algorithms to recover resolution from imaging point spread functions corrupted by spatially-varying signal phase errors. He is also investigating accelerated acquisition and reconstruction methods which exploit sparsity to reduce scan time and improve robustness to image artifacts.

Reference:

T Smith, Z Zun, E Wong, K Nayak. Design and use of variable flip angle schedules in transient balanced SSFP subtractive imaging. *Magn Reson Med* 63(2):537-542, February 2010.

Name: Qun Feng Tan

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Advisor: Shrikanth S. Narayanan

PhD Start Date: Fall 2008

Estimated Graduation: TBD

Research Title: Sparse Representations in Speech Processing and Analysis

Research Summary:

Automatic Speech Recognition (ASR) systems are frequently beset by the problem of noisy audio data. Thus, efficient representation and denoising techniques are most pertinent for good speech recognition accuracies. Tan's research is centered on merging the field of speech denoising with current compressive sensing and sparse representation technologies. He has developed novel techniques for missing data problems in the speech recognition front-end. His other research direction is towards sparse data representation in pattern recognition applications.

Reference:

Qun Feng Tan, Panayiotis G. Georgiou, Shrikanth S. Narayanan, “Enhanced Sparse Imputation Techniques for a Robust Speech Recognition Front-End”, IEEE Transactions on Audio, Speech and Language Processing, 2011

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Advisor: Alice C. Parker

PhD Start Date: Fall 2006

Estimated Graduation: TBD

Research Title: Emulating Vertebrate Retina in Silicon Artificial Retina

Research Summary:

The retina is not merely a sharpening filter for a cable to the visual cortex. Instead, the output of retina generates a highly processed set of extracted features. Many researchers have constructed circuits emulating the beginning stages of the retina (the outer retina), and artificial retinas are in clinical trials. My research is focusing on emulating the functions of the inner retina that sends signals from the outer retina through the optic nerve to the brain, and concentrating on the lateral and feedback connections that occur in the inner retina. The functions are being emulated using analog CMOS VLSI circuits. Issues such as signal stability are being investigated.

Name: David Wheland

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Advisor: Richard Leahy

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2012

Research Title: Structural and network analysis of the cerebral cortex

Research Summary:

It is believed that much of the function of the brain comes from its structure and folding patterns. My research focuses on analyzing such features with a variety of techniques ranging from blind source separation of structural data on the cerebral cortex to graphical modeling.

Reference:

D. Wheland et al., “Analysis of the Cerebral Cortex Using Blind Source Separation”, in International Symposium on Biomedical Imaging. IEEE, 2011.

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Advisor: Shrikanth Narayanan

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: Multimodal Human Behavioral Signal Processing

Research Summary:

Behavioral and social signal processing are emerging research areas that consider not only the physical aspect of various signals but also their meaning in psychological and social context. In order to get better understanding of human behavior, the effort is carried out in several layers. On the lower layer, observational cues are extracted from multimodal recordings, such as audio, video and motion captures. In addition, transcriptions, segmentations and dialog act tags etc. are also prepared. On the higher layer, psychological interpretations are given in form of labels, annotations and scores etc. To bring these two ends together, data driven learning techniques are adopted and computational models inferring the higher level interpretation from the low level descriptors can be built. Human behavior itself is complex in a sense that many dimensions of internal factors shape the observable behavior, and the same intension could be conveyed in different ways. This motivates us to invent new methods computationally and systematically that address these complexities. Nevertheless, our work starts from collecting the multimodal recording, annotations and searching for good low level features, so that the model could be solid grounded.

Reference:

Bo Xiao, Prasanta Kumar Ghosh, Panayiotis Georgiou, Shrikanth S. Narayanan. Overlapped speech detection using long-term spectro-temporal similarity in stereo recording. In proceeding of ICASSP 2011. May 2011. Prague, Czech Republic.

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Advisor: Theodore W. Berger & Shrikanth Narayanan

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2012

Research Title: Learning in Dynamic Synapses Neural Networks and Its Application in Classic Signal Processing

Research Summary:

Short-term and long-term synaptic plasticity play an inevitable role in learning, forming memory and neural computations in the brain. Brain functionality in neural coding and information processing is unarguably tied to the synaptic dynamics. Dynamic Synapses Neural Networks – DSNNs - is a family of biologically inspired neural networks which aim to understand different functional properties of the synapses. My research focuses on the synapse modeling, training multi-layer recurrent DSNNs and applying them to the classic signal processing applications.

I am working on developing a family of stochastic models to represent macroscopic computational and dynamic functionalities of the synapse. A general class of reward learning algorithms is being developed for supervised and unsupervised learning in the recurrent DSNNs. The learning algorithm which is shown to be a biologically plausible learning mechanism was derived from merging Dynamic Programing, Bayesian Inference and Graph Theory concepts. It is shown that the learning algorithm is an extended spike time dependent plasticity - STDP - mechanism adapting the long-term and short-term plasticity, e.g., synaptic weight, synaptic facilitation and vesicle recovery in DSNNs. The DSNN was applied for fence intrusion classification, where its performance is superior to the standard classification techniques. The ongoing research focuses on extending the learning algorithm in large scale DSNNs.

Reference:

A Yousefi, A. A. Dibazar, Theodore W. Berger, “Supervised Learning in a Single Layer Dynamic Synapses Neural Net,” IJCNN 2011

Name: Hang Yuan

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Advisor: C.-C. Jay Kuo

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Energy-Efficient and Cloud-Based Multimedia Services

Research Summary:

The expanding scale and density of data centers has made their power consumption an imperative issue. Data center energy management has become of unprecedented importance not only from an economic perspective but also for environment conservation. The recent surge in the popularity of cloud computing for providing rich multimedia services has further necessitated the need to consider energy consumption. Moreover, a recent phenomenon has been the astounding increase in multimedia data traffic over the Internet, which in turn is exerting a new burden on the energy resources. My research focuses on the energy issues in cloud-based multimedia services, and aims at developing algorithms and systems that offer media services in cloud computing frameworks.

Reference:

Hang Yuan, C.-C. Jay Kuo and Ishfaq Ahmad, “Energy Efficiency in Data Centers and Cloud-Based Multimedia Services: An Overview and Future Directions”, The First International Conference on Green Computing, Chicago, IL, Aug. 2010.

Name: Xuemei Zhao

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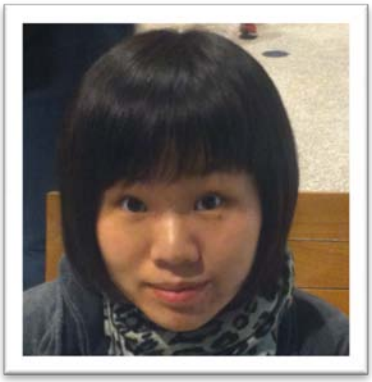
Website: http://www-scf.usc.edu/~xuemeiz/

Advisor: Gérard Medioni



PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Motion Analysis and Scene Understanding from Video

Research Summary:

With the decreasing cost of collecting data, the deluge of surveillance videos makes it necessary to carry out automatic intelligent processing to understand scenes and analyze activities. Xuemei's PhD research focuses on learning high-level knowledge of the scenes like motion pattern from videos, and use it to assist low-level tasks such as detection and tracking, and high-level tasks such as anomaly detection and behavior prediction.

In the unsupervised learning process of motion pattern, local estimated motion flow data is first acquired, and Tensor Voting is used to infer local geometric structure. Making full use of geometric information, a novel multiple manifold clustering algorithm is proposed, based on a combination of multiple similarity kernels. The algorithm is proved to be robust to outliers, and outperforms state-of-the-art methods. Moreover, motion pattern knowledge is used in turn to improve tracking, and experimental results on challenging dataset show its effectiveness.

In the future, motion pattern knowledge will be further used to assist difficult tasks that can't be handled by traditional method like high density crowd tracking, and high-level tasks like abnormal activity detection.

Reference:

Xuemei Zhao, Gérard Medioni, "Robust Unsupervised Motion Pattern Inference from Video and Applications", under double-blind review.

Name: Yinghua Zhu

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Advisor: Krishna S. Nayak

PhD Start Date: Fall 2010

Estimated Graduation: Fall 2015

Research Title: Dynamic 3D visualization of vocal tract shaping during speech

Research Summary:

Noninvasive imaging is widely used in speech research as a means to study the shaping of the vocal tract and dynamics of articulators during speech production. 3D magnetic resonance imaging (MRI) during sustained sounds provides the full geometry of vocal tract. 2D real-time MRI provides dynamics of individual slices through the vocal tract during fluent speech. 3D dynamic imaging would be a major advance as it allows for the visualization of spatial and temporal lingual features simultaneously. Yinghua Zhu's research focuses on developing a novel method for forming 3D dynamic movies of vocal tract shaping during speech production. He acquires multiple sagittal 2D real-time movies with synchronized audios using established methods, and extracts the acoustic features, mel-frequency cepstral coefficients (MFCC), from the audio recordings. 2D real-time MRI movies are time-warped according to the audio alignment using dynamic time warping (DTW). He examines 4 English vowel-consonant-vowel (VCV) utterances /*asa*/, /*aʃa*/, /*ala*/ and /*ara*/. The articulators of interest in the aligned videos are manually segmented, and renderings of the 3D vocal tract dynamics are produced with 78 ms temporal resolution. The tongue features such as grooving, cupping and tipping can be clearly visualized from the 3D dynamics.

Reference:

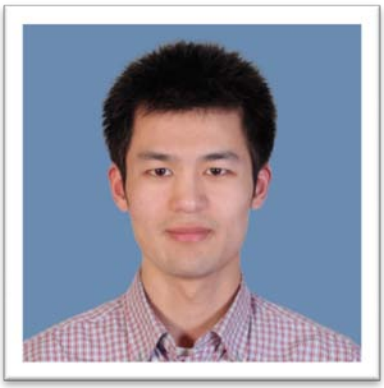
S. S. Narayanan, K. S. Nayak, Sungbok Lee, A. Sethy, and D. Byrd, "An approach to real-time magnetic resonance imaging for speech production," *J. Acoust. Soc. Am.*, vol. 115, pp. 1771-1776, Apr. 2004.

Name: Wentao Zhu

Email: wentaozh@usc.edu

Website: http://neuroimage.usc.edu/GroupMembers.html

Advisor: Richard Leahy



PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: PET reconstruction, leision detection and statistical analysis

Research Summary:

PET as a new functional imaging modality has contributed to the detection and diagnoses of tumors in clinic. However, much remains to be done such as improving the image resolution and decreasing the computation cost. Wentao Zhu's Ph.D. research focuses on PET reconstruction and related topics, including PET leision detection and statistical analysis. He has developed an innovative registration procedure for longitudinal PET images. He also proposed a simple but efficient method to calculate the Patlak parameter, which is an important indicator of the presence of tumors. He is currently working on the variance analysis of the dynamic PET image. Wentao has published a paper in MIC, 2010 about the registration of longitudinal PET images.

Reference:

W. Zhu et al., Longitudinal Registration of Liver PET Scans Using Four Phase CT, *IEEE medical imaging conference*, (2010)

VLSI/CAD

Name: Hamed Abrishami

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Advisor: Massoud Pedram

PhD Start Date: Fall 2005

Estimated Graduation: Fall 2011

Research Title: Reliability-Aware and Low Power Design Techniques

Research Summary:

With the scaling down of the CMOS technologies, leakage power is becoming an increasingly important issue in IC design. There is a trade-off between subthreshold leakage power consumption and performance in the circuit; i.e., for higher performance, leakage power consumption must be sacrificed and vice versa. Meanwhile, timing analysis during synthesis and physical design is pessimistic which means there are some slacks available to be traded for leakage power minimization. This power minimization can be done after the sign-off which is more accurate and realistic than if it is done before the sign-off. The available slack can be traded for leakage power minimization by footprint-based cell swapping and threshold voltage assignment. I introduce my post sign-off leakage power optimization problem as a nonlinear mathematical program and solve it by using conjugate gradient (CG) method. I set up a novel transformation technique to manipulate the constraints of the optimization problem to be solved by CG. I show that by doing this optimization we can reduce the leakage power consumption by 34% on average in comparison with no power optimization after sign-off. On the other hand, With the CMOS transistors being scaled to sub 45nm and lower, reliability effects has become a major concern due to its impact on the performance of VLSI circuits (aging effects) or accuracy of the operations (soft error). I have introduced design techniques to overcome these reliability effects as well.

Reference:

H. Abrishami et al., "Post Sign-Off Leakage Power Optimization," To appear in Proc. of Design Automation Conference, June 2011.

Name: Prasanjeet Das

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Advisor: Sandeep Gupta

PhD Start Date: Spring 2009

Estimated Graduation: Fall 2012

Research Title: Development of a variability aware systematic framework for the delay marginality validation of high performance chips.

Research Summary:

Despite advances in design and verification, it is becoming increasingly common for high performance chip designs to undergo multiple silicon spins which can be attributed to the shortcomings of current validation approaches in identifying the causes of serious circuit misbehaviors, in particular delay marginalities caused by low-level effects (such as, delay variations, ground bounce, and crosstalk) and aggravated by process variations. Prasanjeet Das's PhD research focuses on the development of a systematic method to determine the worst case delay of a small batch of chips in the first fabricated lot (obtained for validation). His research will help reduce the number of silicon spins (ideally to a maximum of two, assuming perfect redesign) and can help more aggressive design approaches by reducing the guard banding against variability. He had successfully developed a method to capture variability in advanced delay models (characterized for 65nm) for post silicon delay related activities. He had also developed a novel approach for variability aware vector generation for post silicon timing characterization to strengthen the existing approaches for post-silicon validation as well as delay testing and speed binning. He is currently investigating methods for efficient post silicon validation by segmentation of process variability envelopes based on die-to-die and within die process variability information. Prasanjeet is also the recipient of MS honors award 2008, Academic Excellence award 2009 and Honorable mention TA award 2010 from USC and was awarded three gold medals for academic excellence from Nagpur University (India) during his bachelors.

Reference:

P. Das and S.K. Gupta, "On generating vectors for efficient post silicon delay characterization", *submitted to ITC 2011*

Name: Aditya Deshpande

Email: adeshpan@isi.edu

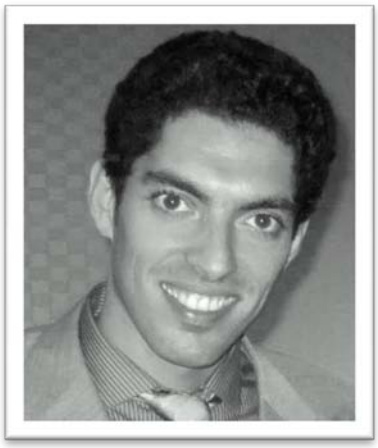
Advisor: Jeffrey Draper

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Summary:

Semiconductor devices have always been vulnerable to soft errors due to atmospheric radiation. Recent advances in VLSI technology processes have further exacerbated the problem of susceptibility of semiconductor devices to soft errors. Therefore, a need exists to design VLSI components which are robust to soft errors. Much of the prior focus of soft errors addressed semiconductor memories, but with recent technology changes, the actual computational logic also needs to be protected from soft errors. Current VLSI approaches for protection of computational logic include Triple Modular Redundancy (TMR), use of voter circuits and using custom cells like DICE. These approaches have significant area/power penalties. A promising new technique uses a class of algorithms which are based on Residue Arithmetic Coding. With the use of residue arithmetic coding, certain robust computational elements can be designed with reduced overhead penalties. Aditya Deshpande has been looking into using Residue Arithmetic Coding for generating signatures to detect soft errors occurring in combinational logic.



Name: Mohammad Ghasemazar

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Website: http://atrak.usc.edu/~ghasemazar/

Advisor: Massoud Pedram

PhD Start Date: Fall 2007

Estimated Graduation: Fall 2011

Research Title: Circuit and chip level variation-aware power optimization in digital VLSI systems

Research Summary:

In today's IC design, one of the key challenges is the increase in power consumption of the circuit which in turn shortens the service time of battery-powered electronics, and increases the cooling and packaging costs of electronic chips and systems. On the other hand, with the increasing levels of variability in the characteristics of nanoscale CMOS devices and VLSI interconnects and continued uncertainty in the operating conditions of VLSI circuits, achieving power efficiency and high performance in electronic systems under such variations has become a daunting, yet vital, task.

Mohammad Ghasemazar's Ph.D. research investigates power optimization techniques in CMOS VLSI design both at circuit level and chip level, while considering the variations in fabrication process or operating conditions of such circuits and systems. He has presented and solved the problem of power-delay optimal design of linear pipeline utilizing soft-edge flip-flops as a circuit level technique as well as a chip level solution to low power design that minimizes the total power dissipation of a Chip Multiprocessor while maintaining an average system-level throughput. The minimum power solution is achieved by applying Dynamic Voltage and Frequency Scaling, core consolidation, and task assignment in a hierarchical global power management approach.

Reference:

M. Ghasemazar, M. Pedram, "Minimizing the Energy Cost of Throughput in a Linear Pipeline by Opportunistic Time Borrowing," *International Conference on Computer Aided Design* (ICCAD), 2008.

Name: Hadi Goudarzi

Email: hgoudarz@usc.edu

Advisor: Massoud Pedram

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2013

Research Title: Resource Allocation in Cloud Computing Systems

Research Summary: Demand for computing power has been increasing due to the penetration of information technologies in our daily interactions with the world both at personal and community levels, encompassing business, commerce, education, manufacturing, and communication services. At the personal level, the wide scale presence of online banking, e-commerce, SaaS (Software as a Service), social networking etc. produce workloads of great diversity and enormous scale. At the same time computing and information processing requirements of various public organizations and private corporations have also been increasing rapidly. Such a dramatic increase in the computing demand requires a scalable and dependable information technology (IT) infrastructure comprising of servers, storage, networks, physical facilities and IT workforce to name a few. Cloud computing system is one of the most important solutions to provide scalable and dependable IT infrastructure.

SLA-based resource allocation problem for multi-tier applications in the cloud computing is considered in this research. We model the Multi-tier applications as network of queues and use the simplified response time equations to determine resource allocation and maximize the total profit by considering the operational cost of the servers. The processing, memory requirement, and communication resources are considered as three dimensions in which optimizations are performed.

Reference:

Hadi Goudarzi and Massoud Pedram. Maximizing Profit in Cloud Computing System via Resource Allocation. Data Center Performance Workshop 2011.

Name: Inkwon Hwang

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Website: http://atrak.usc.edu/~inkwonhw/

Advisor: Massoud Pedram

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2013

Research Title: Dynamic power management in data centers

Research Summary:

Virtualization has become a very important technology, which has been adopted in many enterprise computing systems and data centers. Virtualization makes resource management and maintenance easier and can decrease energy consumption through resource consolidation. This project starts by understanding the effect of the power savings and response time change as a function of different virtualization scenarios for different workloads. The next step is achieving power savings through CPU consolidation. Because our target application is a web-based application, we will verify the effectiveness of the proposed CPU consolidation through SPECWeb benchmark results.

Reference:

M. Pedram and I. Hwang, "Power and performance modeling in a virtualized server system," Green Comupting Workshop, 39th International Conference on Parallel Processing Workshop, Sep. 2010, pp. 520-526.

Name: Jonathan Joshi

Email: jjoshi@usc.edu

Advisor: Alice C. Parker

PhD Start Date: Fall 2008

Estimated Graduation: Spring 2012

Research Title: Demonstrating Learning by Emulating Structural Plasticity in Silicon Cortical Neural Networks

Research Summary:

While synaptic plasticity (change in synaptic weights) is an important mechanism supporting memory and learning, the addition of new synaptic connections between neurons is also a mechanism thought to be required for learning. For engineers trying to recreate biological neural networks that learn, the rewiring of the cortex over time is a mechanism that must be included. Jonathan's research is to build an *in silico* neuromorphic network that can restructure its synaptic connections autonomously. The restructuring of these synaptic connections will occur on detecting changes in neural and synaptic activity. He is developing a method called *synapse stealing* with which restructuring can be implemented *in silico*. It is a neuromorphic network that transfers an existing unused synapse between two neurons (an existing pre-synaptic and post-synaptic (target) neuron) to another pre-synaptic neuron. As a result the connection between the new presynaptic neuron and the post-synaptic neuron strengthens. An additional result of his research is cell libraries of tunable neural circuits that can be part of a design methodology, helping designers build larger neuromorphic networks. He has been involved in trend setting projects namely developing neural hardware using nanotechnology and developing one of the first *in silico* glial cells to be reported.

Reference:

Jonathan Joshi, Alice C. Parker and Chih-Chieh Hsu, "A Carbon Nanotube Cortical Neuron with Spike Timing Dependant Plasticity", International Conference of the IEEE Engineering in Medicine and Biology Society 2009

Name: Mohammad Mirza-Aghatabar

Website: http://www-scf.usc.edu/~mirzaagh/

Advisor: Melvin A. Breuer

PhD Start Date: Fall 2008

Estimated Graduation: Fall 2012

Research Title: Redundancy and Partitioning for Yield/Area Maximization of SoC in Nano-Technologies with High Defect densities

Research Summary: Reduced scaling of feature sizes and process variations in CMOS nano-technologies introduce manufacturing anomalies that significantly reduce yield. If applied appropriately, replicating modules (redundancy) can increase yield. Modules with different sizes (areas) have different yields and thus need different number of spares. The selection of which redundant copy of a module to use as well as directing data to and from such modules is carried out using steering logic[1]. The area and yield of this circuitry is important. The focus of this thesis is to develop algorithms and heuristics for the maximization of silicon yield/area of linear and non-linear circuit structures by (*i*) partitioning the original circuit into modules, (*ii*) replicating modules, and (*iii*) inserting steering logics.

A key issue in maximizing the effectiveness of redundancy is the granularity of the modules to which it is applied. In this research we focus on the impact of (*i*) granularity, (*ii*) uniformity in area (yield) of modules (sub-circuits), together with (*iii*) the use of appropriate numbers of spare copies of modules with the goal of maximizing yield/area. We prove that under certain reasonable assumptions, partitioning a circuit into a large number of equal-area modules and using one spare maximizes yield/area.

Reference:

M. Mirza-Aghatabar, M.A. Breuer, S.K. Gupta, “Algorithms to maximize yield and enhance yield/area of pipeline circuitry by insertion of switches and redundant modules”, Proc. Design, Automation, and Test in Europe, pp. 1249-1254, Mar. 2010.

[1] The generic term for a fork, join and switch is steering logic

Name: Doochul Shin

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Advisor: Sandeep K. Gupta

PhD Start Date: Fall 2006

Estimated Graduation: Fall 2011

Research Title: Circuit designing and synthesis techniques for error tolerance applications

Research Summary:

The concept of error tolerance has been proposed to mitigate the effect of the non-idealities such as increasing defect rates and increasing variations due to the manufacturing process. Main concept of error tolerance is that for a wide variety of applications including audio, video, graphics, and wireless communications, defective chips that produce erroneous values at its outputs can be acceptable, provided the errors are of certain types and their severities are within application-specified thresholds. Previous research on error tolerance has focused on identifying such defective but acceptable chips during post-fabrication testing to improve yield. Doochul Shin's research introduce a completely new approach to exploit error tolerance based on the following observation: If certain deviations from the nominal output values are acceptable, then we can exploit this flexibility during circuit design or synthesis to reduce circuit cost as well as to increase yield. He is exploring approximate design for three different scenarios: where the nominal function is described (i) as a Boolean function (typically in the form of truth table), (ii) using a given gate level circuit netlist, or (iii) as an architecture, as is often the case for datapath elements like adders and multipliers. For each of the above scenarios, he is developing new design or synthesis methods to optimize circuit design for a given error tolerance threshold.

Reference:

Doochul Shin, and Sandeep K. Gupta, “A new circuit simplification method for error tolerant applications,” In *Proc. Design, Automation and Test in Europe,* 2011.

Name: Yanzhi Wang

Email: yanzhiwa@usc.edu

Website: atrak.usc.edu/~yanzhiwa/

Advisor: Massoud Pedram

PhD Start Date: Fall 2009

Estimated Graduation: Spring 2014

Research Title: System level power management: architecture and algorithm design.

Research Summary:

My research in Prof. Pedram's research group mainly focuses on two areas: hybrid electrical energy storage (HEES) system and dynamic power management. The main idea of the first topic is that one single type of electrical energy storage element, such as Lithium-ion battery, supercapacitor, etc., cannot fulfill the all the needs of modern energy storage system, e.g., high energy density, high power capacity, low response time, etc. Thus we develop the HEES system to exploit the benefits of different types of energy storage elements, while hiding their shortcomings. I developed charge allocation, migration, and other optimization techniques in such area and co-authored a couple of papers.

The second area is dynamic power management of hardware components such as CPU, memory, hard disk and WLAN cards, etc. The main idea is to utilize the idle periods of such devices and to shut down or slow down such devices when they are (supposed to be) idle for a long time. I incorporated reinforcement learning techniques in dynamic power management and see significant power reduction. A paper in this area has been accepted by the Design Automation Conference, the most premier conference in the VLSI/CAD area.

Reference:

Yanzhi Wang, Qing Xie, Ahmed C. Ammari, and Massoud Pedram, "Deriving a near-optimal power management policy using model-free reinforcement learning and Bayesian classification," *Proc. of Design Automation Conference*, June 2011.

2011 MHI Ph.D. Scholars

2011 Ming Hsieh Institute Ph.D. Scholars

The following five senior Ph.D. students are the 2011 Ming Hsieh Institute Ph.D. Scholars. They were selected on the basis of ther outstanding research accomplishment, promise, and desire for an academic career beyond the Ph.D.

Firooz Aflatouni
Research Interest: RF inspired photonics and low power integrated RF and millimeter-wave systems in silicon-based processes.
PHE 416, (213) 740-3058 aflatoun@usc.edu
Research summary page: 69

Prasanta Kumar Ghosh
Research Interest: Understanding human speech communication with application to machine recognition of speech especially inspired by the speech production and perception link.
EEB405, (213) 821-2433 prasantg@usc.edu
Research summary page: 140

Samir Sharma
Research Interest: signal processing with a focus in inverse ill-posed imaging problem; currently exploring the application of compressed sensing and parallel imaging for accelerated water-fat MRI.
EEB 414, (213) 740-4650 sdsharma@usc.edu
Research summary page: 161

Chuan Wang
Research Interest: Carbon nanotube nanoelectronics and macroelectronics.
RTH B118, (213) 821-4208 chuanwan@usc.edu
Research summary page: 91

Omer Faruk Yilmaz
Research interest: Advanced optical signal processing for reconfigurable fiber optical networks with emphasis on coherent detection.
EEB 533, (213) 740-0024 oyilmaz@usc.edu
Research summary page: 127

2010 Ph.D. Dissertations

2010 Ph.D. Dissertations

- **Mudarak Alharashani,** Dissertation Title: "Relaxing Convergence Assumptions for Continuous Adaptive Control." Advisor: Michael Safonov.

- **Ganesha Bhaskara,** Dissertation Title: "Topology Generation for Protocol Testing: Methodology and Case Studies." Advisor: Sandeep Gupta.

- **Adam Bushmaker,** Dissertation Title: "Raman Spectroscopy and Electrical Transport in Suspended Carbon Nanotube Field Effect Transistors under Applied Bias and Gate Voltages." Advisor: Stephen Cronin.

- **Jae Chul Cha**, Dissertation Title: "Optimal Defect-Tolerant SRAM Designs in terms of Yield-per-Area under constraints on soft-error resilience and performance." Advisor: Sandeep Gupta.

- **Michael Chang**, Dissertation Title:"A Revised Computational Procedure for Calculating Zames-Falb Multipliers." Advisor: Michael Safanov.

- **Hao Chen**, Dissertation Title: "Topics in High Voltage Pulsed Power Plasma Devices and Applications." Advisor: Martin Gundersen

- **Yongjin Cho**, Dissertation Title: "Dependent R-D Modeling for H.264/SVC Bit Allocation." Advisor: C.-C. Jay Kuo

- **Ta-Shun Chu**, Dissertation Title: "Silicon-Based Broadband Short-Range Radar Architectures and Implementations." Advisor: Hossein Hashemi.

- **Hyung-Joon Chu**, Dissertation Title: "The Growth and Characterization of III-V Semiconductor Nanowire Arrays by Nanoscale Selective Area Metalorganic Chemical Vapor Deposition." Advisor: P. Daniel Dapkus.

- **Yunyang Dai**, Dissertation Title: "Advanced Intra Prediction Techniques for Image and Video Coding." Advisor: C.-C. Jay Kuo.

- **Reza Gholizadeh**, Dissertation Title: "Mitigation of Ion Motion in Future Plasma Wakefield Accelerators." Advisor: Martin Gunderson.

- **Amitabha Ghosh**, Dissertation Title: "Algorithmic Aspects of Throughput-Delay Performance for Fast Data Collection In Wireless Sensor Networks." Advisor: Bhaskar Krishnamachari.

- **Ankush Goel,** Dissertation Title: "Integrated Multi-band and Wideband Reconfigurable Wireless Receivers." Advisor: Hossein Hashemi.

- **Pai-Han Huang**, Dissertation Title: "Time synchronization and scheduling in underwater wireless networks." Advisor: Bhaskar Krishnamachari.

- **Hua Hui**, Dissertation Title: "Signal Processing Methods for Interaction Analysis of Functional Brain Imaging Data." Advisor: Richard Leahy.

- **Ying Huo**, Dissertation Title: “A Multi-Layer Robust Adaptive Fault Tolerant Control System for High Performance Aircraft.” Advisor: Petros Ioannou.

- **Weirong Jiang**, Dissertation Title: “High Performance Packet Forwarding on Parallel Architectures.” Advisor: Viktor Prasanna.

- **Shahryar Karimi-Ashtiani,** Dissertation Title: “Theory and Simulation of Diffusion Magnetic Resonance Imaging on Brain's White Matter.” Advisor: C.-C. Jay Kuo.

- **Vikash Khatri,** Dissertation Title: “Intelligent Video Surveillance using Soft.” Advisor: Gerard Medioni.

- **Samuel Kim**, Dissertation Title: “Contextual Modeling of Audio Signals Toward Information Retrieval.” Advisor: Shirkanth Narayanan.

- **Yoon Chul Kim**, Dissertation Title: “Fast Upper Airway MRI of Speech.” Advisor: Krishna Nayak.

- **May-chen Kuo**, Dissertation Title: “Motion Capture Data Compression: Algorithms and Performance Evaluation.” Advisor: C.-C. Jay Kuo.

- **Youngmin Kwak**, Dissertation Title: “Advanced Liquid Simulation Techniques for Computer Graphics Applications.” Advisor: C.-C. Jay Kuo.

- **Kun-Han Lee,** Dissertation Title: “Investigating Statistical Modeling Approaches for Reservoir Characterization in Waterfloods from Rates Fluctuations.” Advisor: Antonio Ortega.

- **Ling Lu**, Dissertation Title: “Photonic crystal nanocavity lasers for integration.” Advisor: John O’Brien.

- **Scott Moeller**, Dissertation Title: “Dynamic Routing and Rate Control in Stochastic Network Optimization: from Theory to Practice.” Advisor: Bhaskar Krishnamachari.

- **Nasir Mohyuddin**, Dissertation Title: “Low Power and Reliability Assessment Techniques for Advanced Processor Design.” Advisor: Massoud Pedram.

- **Emily Mower**, Dissertation Title: “Emotions in Engineering: Methods for the Interpretation of Ambiguous Emotional Content.” Advisor: Shrikanth Narayanan.

- **Ehsan Pakbaznia**, Dissertation Title: “Energy-Efficient Shutdown of Circuit Components and Computing Systems.” Advisor: Massoud Pedram.

- **Pankaj Pankaj,** Dissertation Title: “Theory, Implementations and applications of single-track designs.” Advisor: Peter Beerel.

- **Avinash Rao Parnandi**, Dissertation Title: “A Framework for Automated Administration of Post Stroke Assessment Test.” Advisor: Gaurav Sukhatme.

- **Kimish Patel**, Dissertation Title: “Energy Efficient Design and Provisioning of Hardware Resources in Modern Computing Systems.” Advisor: Massoud Pedram.

- **Sundeep Pattem**, Dissertation Title: “Joint Routing and Compression in Sensor Networks: From Theory to Practice.” Advisor: Bhaskar Krishnamachari.

- **Gennady Poberezhskiy**, Dissertation Title: “Sampling with Internal Filtering in Digital Radios.” Advisor: William Lindsey.

- **Shesha Raghunathan**, Dissertation Title: “Topics in modeling, analysis and simulation of near-term quantum physical systems with continuous monitoring.” Advisor: Todd Brunn.

- **Joaquin Rapela**, Dissertation Title: “Characterization of visual cells using generic models and natural stimuli.” Advisor: Jerry Norberto, Mendel Grzywacz.

- **Godwin Shen**, Dissertation Title: “Lifting Transforms on Graphs: Theory and Applications.” Advisor: Antonio Ortega.

- **Hooman Shirani-Mehr**, Dissertation Title: “Channel State Information Feedback, Prediction and Scheduling for the Downlink of MIMO-OFDM Wireless Systems.” Advisor: Caire Giuseppe.

- **Daniel Singleton**, Dissertation Title: “The Physics and Application of Compact Pulsed Power to Transient Plasma Ignition.” Advisor: Martin Gunderson.

- **Soraya Taghavi,** Dissertation Title: “Quantum Computation and Optimized Error Correction.” Advisor: Daniel Lidar.

- **Tanaphol Thaipanich**, Dissertation Title: “Image and Video Enhancement through Motion Based Interpolation and Nonlocal-Means Denoising Techniques.” Advisor: C.-C. Jay Kuo.

- **Gautam Thatte**, Dissertation Title: “Applications of Estimation and Detection Theory in Decentralized Networks.” Advisor: Urbashi Mitra.

- **Qingbo Wang**, Dissertation Title: “Multi-Softcore Architectures and Algorithms for a Class of Sparse Computations.” Advisor: Viktor K. Prasanna.

- **Ping-Hao Wu,** Dissertation Title: “Efficient Management Techniques For Large Video Collections.” Advisor: C.-C. Jay Kuo.

- **Qi Zhang**, Dissertation Title: “Advanced Techniques for High-Fidelity Video Coding.” Advisor: C.-C. Jay Kuo.

- **Zungho Zun**, Dissertation Title: “Assessment of Myocardial Blood Flow in Humans Using Arterial Spin Labeled MRI.” Advisor: Krishna Nayak.

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