UCLA

Annual Report
2009-2010

Henry Samueli School of Engineering and Applied Science

Electrical **Engineering**

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A Year in **Review**

I am honored to share with you the achievements of the UCLA Electrical Engineering Department during the 2009-2010 academic year. With budget cuts creating a complex academic landscape across higher education, I invite you to examine the research breakthroughs and scholarly accomplishments highlighted in this annual report:

■ Professor **Henry Samueli** was awarded the prestigious **2010 UCLA Medal.** The Medal is awarded to individuals who have made extraordinary contributions to their profession, to higher education, to society, and to the university. Previous medal recipients include former Presidents Bill Clinton and Jimmy Carter; United Nations Secretary-General Ban Ki-moon; planetary physicist Carl Sagan; and others. His other recognitions include election to the National Academy of Engineering in 2003. He is also a co-founder of Broadcom, which is one of the world's leading companies in the area of communications circuits.

■ **NSF** funds **Expedition into Hardware-Variability-Aware Software for Efficient Computing with Nanoscale Devices**. Professor **Mani Srivastava** will be the Deputy Director. Eleven other researchers from University of Michigan, Stanford University, UC Irvine and the University of Illinois at Urbana-Champaign will make this team. Additional faculty members from Electrical Engineering Department include **Lara Dolecek** and **Puneet Gupta**.

■ **King Abdulaziz City for Science & Technology (KACST)** in Saudi Arabia and the Henry Samueli School of Engineering and Applied Science have signed an agreement that establishes a **Center of Excellence in Green Nanotechnology** to promote educational and research exchanges, as well as an agreement with UCLA for research in nanoelectronics and clean energy for the next 10 years.

The department is making great strides in preparing the next generation of academic scholars. The following Electrical Engineering Ph.D. graduates accepted academic positions in 2009-2010:

■ Dr. Qun Jane Gu (Ph.D. '07), University of Florida (Advisor: **Frank Chang**).

■ Dr. Yu Hu (Ph.D. '09), University of Alberta (Advisor: **Lei He**).

■ Dr. Yiyu Shi (Ph.D. '09), Missouri University of Science and Technology (Advisor: **Lei He**).

■ Dr. Hao Yu (Ph.D. '07), Nanyang Technological University (Advisor: **Lei He**).

■ Dr. Shalabh Gupta (Ph.D. '09), Indian Institutes of Technology, Bombay (Advisor: **Bahram Jalali**).

■ Dr. Kevin Tsia (Ph.D. '09), Hong Kong University (Advisor: **Bahram Jalali**).

■ Dr. Amarjeet Singh (Ph.D. '09), Indraprastha Institute of Information Technology, Delhi (Advisor: **William Kaiser**).

■ Dr. Hyunggon Park (Ph.D. '08), Ewha Womans University, South Korea (Advisor: **Mihaela van der Schaar**).

■ Dr. Thomas Schmid (Ph.D. '09), The University of Utah (Advisor: **Mani Srivastava**).

■ Dr. Heemin Park (Ph.D. '06), Sookmyung Women's University, Seoul (Advisor: **Mani Srivastava**).

■ Dr. Jitkomut Songsiri (Ph.D. '10), Chulalongkorn University, Thailand (Advisor: **Lieven Vandenberghe**).

■ Dr. Lap Yeung (Ph.D. '10), Chinese University of Hong Kong (Advisor: **Ethan Wang**).

The department's **Industrial Affiliates Program (IAP)** has grown significantly over the past year. Both the department and IAP members have been enriched by close collaboration, such as:

■ Cisco funded Professor **Lei He** on "Fault Tolerance for FPGA-based Systems".

■ Professors **Frank Chang**, **Behzad Razavi**, and **Jason Woo** were funded by Northrop Grumman for their research "Mixed Signal and RF CMOS IC Design," as part of the US Air Force/DARPA ELASTx Program.

■ Assistant Professor **Ben Williams** received funding from JPL as part of a SURP award (Strategic University Research Partnerships) entitled "Phase-locking of Boradband Terahertz Quantum Cascade Laser with High Quality Beam Profile."

We are proud of the accomplishments of our department. I want to also recognize our faculty, staff, students, alumni, and industry sponsors for their hard work and contributions.

M.C. Frank Chang
Chair, Electrical Engineering Department

Professor

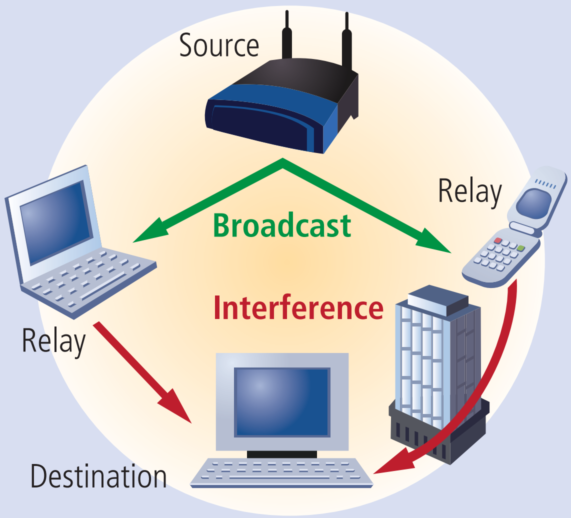
Suhas N. **Diggavi**

Explores Network Information Theory

Network information theory deals with fundamental characterizations of information flow and/or compression over communication networks. While there are satisfying characterizations for flows on networks represented as graphs (suitable for wired networks), there are few complete characterizations for networks with more complicated interactions as those encountered in wireless networks. Given the discouraging state of affairs, a natural question is whether there are methodologies to advance the understanding of the problem.

In work with collaborators, Professor Diggavi has posited that one gains insight into these network communication problems by looking for (provable) approximate characterizations, with the hope that in terms of engineering solutions, these might actually be enough. Underlying these approximations are exact results for deterministic/lossless network communications. This approach can be illustrated using a few problems that are long-standing open questions.

Research in wireless communications has several decades of storied history, and significant progress has been made. However, almost every system is a single-hop system where the wireless link is used as a last hop in an otherwise wired network. Currently, motivated by the need for increased wireless coverage and capacity, there is an increasing interest in wireless relay networks, where there is a network of wireless nodes which cooperate to deliver information from a source to destination (see figure).



A cooperative network where relay nodes assist the communication between source and destination nodes.

The information theoretic characterization of maximum reliable transmission rates over such networks has been an unresolved question for nearly four decades. In wireless communication, the main bottleneck is transmissions are broadcast and can be overheard not only by the intended receiver, but also from all other receivers that are close to it. Thus, simultaneous transmissions interfere at the receivers, albeit at different signal strengths. Most of the currently proposed and used network architectures artificially try to create a wired network architecture in wireless networks by treating interference as noise, which wastes precious wireless resources.

In collaboration with Salman Avestimehr (Cornell), and David Tse (Berkeley), Professor Diggavi has developed a new transmission strategy called *quantize-map-and-forward* that harnesses the signal interaction rather than avoiding it. This new approach not only offers a simple and robust cooperation strategy, but it is the first strategy that is theoretically provable to be (approximately) optimal for arbitrary wireless networks, i.e., within a constant number of bits from the optimal. In contrast, it was shown that most of the known strategies do not enjoy this property and can be quite far from optimality. Underlying this result is an exact information-theoretic max-flow / min-cut characterization of information flow over a deterministic relay network, which facilitated the development of this new coding strategy for noisy Gaussian networks.

Over the past few years, multimedia content delivery has been the dominant source of traffic over the internet. This motivates the second example, illustrating the philosophy, on reliable and efficient delivery of content that is distributed in different parts of the network. When many users attempt to download bandwidth hungry applications, like video, the network can get congested and unreliable. To guarantee reliability, one solution is to transmit redundant information over multiple routes. The goal of multiple description data compression is to give a graceful degradation of performance in the presence of such route failures, for example, by delivering lower video quality when there are failures. Although such schemes have been studied since the late 1970s, the optimal strategy for a general number of routing paths is a long-standing open question in network information theory. In collaboration with Chao Tian (AT&T Labs) and Soheil Mohajer (EPFL), Professor Diggavi has solved this problem to within a fraction of a bit for an arbitrary number of descriptions. This was done by demonstrating both a new data compression technique and a new theory that demonstrated its (approximate) optimality.

These results show that characterizations, within a constant number of bits approximation, may be a promising direction to get insight into network communication problems. Professor Diggavi and collaborators have managed to extend this approach to many other problems, such as the role of layering in network communications, and harnessing signal interactions for multiple flows in wireless networks. Professor Diggavi is actively pursuing this foundational approach to network communication problems.

Assistant Professor

Lara **Dolecek**

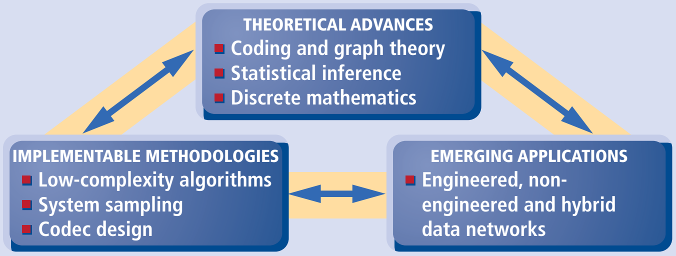
Investigates Applied Mathematical Models

Assistant Professor Lara Dolecek joined the Electrical Engineering Department in January 2010. Her research interests are in mathematical modeling, statistical inference and computational methods with applications to high-performance complex systems for data storage, processing and analysis. A research group led by Professor Dolecek is currently investigating a range of exciting theoretical problems and methodologies with a particular emphasis on "putting the theory around observed phenomena" as they are arising in future engineered and non-engineered information systems.

One of the most fundamental questions regarding any information system is reliable data communication and retrieval. Historically, this topic has been a focal point of well-established fields of information and coding theory. What makes this problem particularly challenging for the emerging complex systems is unprecedented volumes of data need to be compactly and reliably manipulated under growing operational uncertainty. In order to design better systems, we have to re-think governing mathematical models and the associated performance metrics.

In the context of high-speed communication networks, coding systems based on graphical structures and message-passing decoding algorithms have provided revolutionary means of low-delay, low-complexity data recovery. Subsequent empirical results showed — rather surprisingly — that the benefits of such coding systems substantially decrease when the probability of the system failure needs to be extremely low. Naturally, such observations are critical impediments for the advancement of practical systems. We recently proposed a novel framework, rooted in rigorous mathematics, that explains the nature of such system failures. In turn, this theoretical framework enabled very fast performance prediction using sophisticated statistical methods, reduction of the convergence speed of decoding algorithms, and provably better encoding schemes. The end result is an improvement in performance by several orders of magnitude of practical communication systems, such as those employed in Ethernet and satellite systems.

Building on the success of this experience, we are currently investigating novel computational methods and statistical models that are suitable for emerging engineered systems (e.g., memory/storage enterprises), non-engineered systems (e.g., social networks), and for hybrid systems (e.g., smart grid). While such systems are clearly operationally distinct, a common thread amongst a range of applications is that each system is itself described by many random parameters, thus deeming a comprehensive examination of the system behavior unfeasible.



The research program is premised on a tight intercoupling of fundamental theoretical contributions in mathematical sciences, development of practical methodologies and demands by future applications.

Our objective is to compactly characterize system failure as a rare event, and to subsequently use this insight for a more reliable system design that can avoid rare, albeit catastrophic, failures. In our spirit of "putting the theory around observed phenomena," we have devised statistical sampling algorithms using the theory of large deviations that can quickly zoom in on the dominant memory failure mechanism, typically caused by variations in process technology. Our algorithm can accurately predict the performance in one-millionth of the time needed by conventional Monte Carlo methods. Another recent contribution from Professor Dolecek's group concerns emerging Flash memory technology. Flash technology is already penetrating the market of smart phones, laptops, and e-books, and is being introduced into large-scale data centers. A critical issue of this technology is the physical wearout of memory, as it directly affects reliability and price. Counterintuitive to existing solutions that pose strict requirements on read/write operations, our approach relaxes this tight requirement. It instead uses ideas from additive and combinatorial number theory to devise efficient algorithms to compensate for physical failures. With its distinct cost-reducing benefit, this mathematical approach has a potential to impact future ubiquitous memory technologies. Such advances, cutting across multi-dimensional statistical inference, discrete mathematics, and low-complexity algorithms, will undoubtedly constitute indispensable computational tools for information systems of the future.

Professor

Tatsuo **Itoh**

Receives 2009 EuMA Outstanding Career Award

Professor Tatsuo Itoh is the recipient of 2009 EuMA Outstanding Career Award and is the first non-European to receive the award.

The European Microwave Association (EuMA®) is an international non-profit association with a scientific, educational and technical purpose. The aim of the Association is to develop in an interdisciplinary way, education, training, and research activities, including:

- Promoting European microwaves
- Networking and uniting microwave scientists and engineers in Europe
- Providing a single voice for European microwave scientists and engineers in Europe
- Promoting public awareness and appreciation of microwaves

The EuMA has several feature activities, one of which is the annual European Microwave Week with four international conferences, including the European Microwave Conference celebrating its 40th anniversary in 2010.

European Microwave Association provides two awards annually. The Outstanding Career Award was established in 2008 to recognize an individual "whose career has exemplified outstanding achievements in the field of Microwaves". The award consists of a bronze medal carrying the name of the award and the name of the recipient.

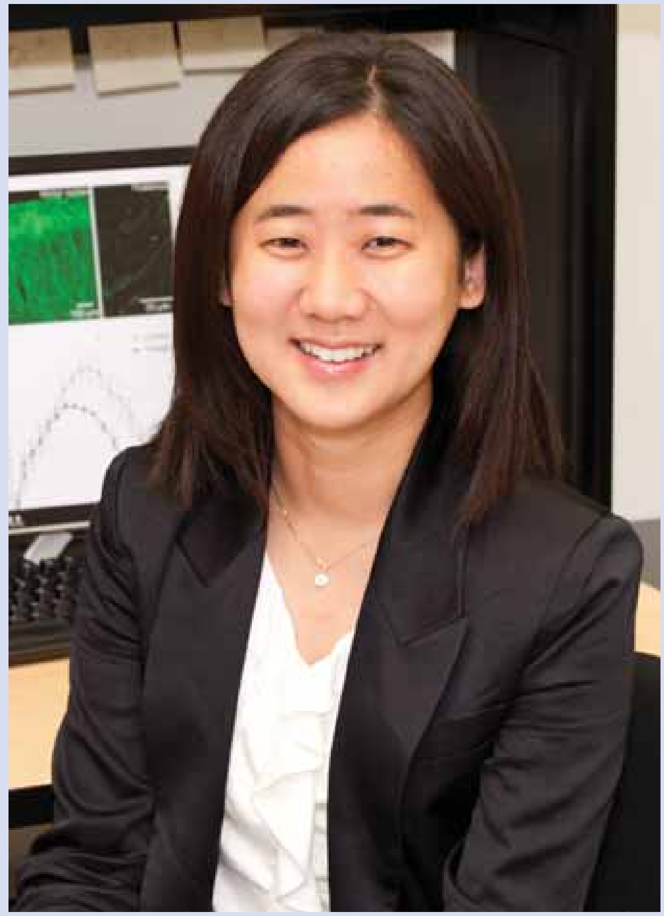
Professor Itoh checks the performance of 2-dimensional metamaterial circuits

Assistant Professor

Jin Hyung **Lee**

Develops Brain Scanning Tecnology

Professor Jin Hyung Lee is working on the new Optogenetic Functional Magnetic Resonance Imaging (ofMRI) technology that holds great promise in analyzing and debugging the brain circuit.

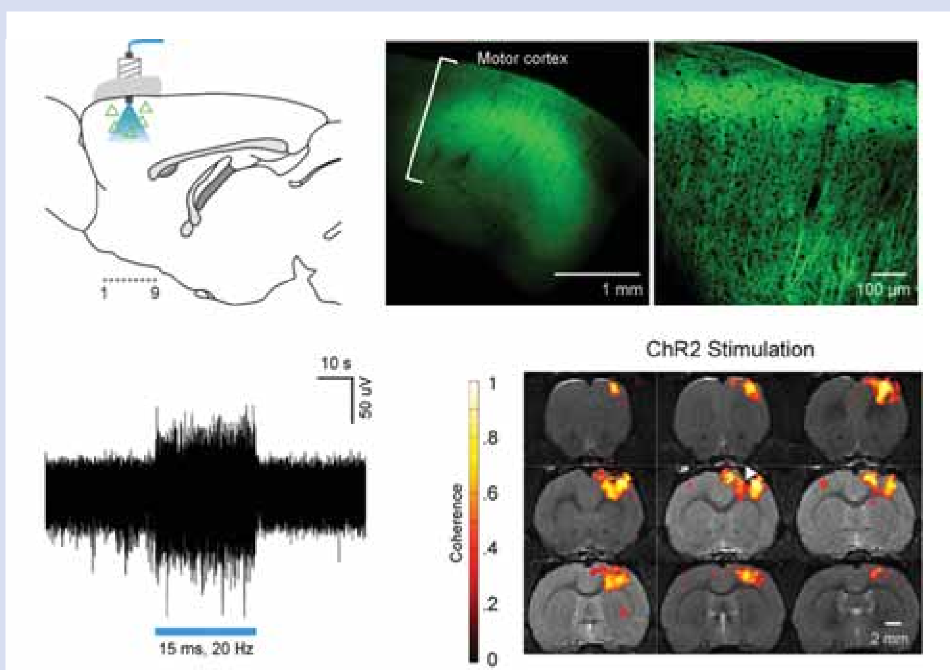


The human brain forms a highly complex circuit that uses electrical and chemical signals to communicate. It consists of approximately 100 billion neurons and 300 billion glial cells that support the activity of neurons. Furthermore, the hundreds of billions of neurons and glial cells also come in various different cell types, which are categorized based on their shape, location, genetic properties, and the chemicals used for communication. These brain circuit elements are densely packed with complex wiring that connects each other which makes it extremely difficult to understand the circuit's connection topology and function.

Different state-of-the art methods to understand the brain circuit include microscopic approaches looking at small scale connections with electron and light microscopy, and large scale connection topologies using neuronal tracers and diffusion tensor MRI. These approaches are analogous to many approaches used by electronic circuit testing. However, no methods to debug the brain circuit by triggering specific circuit element while non-destructively monitoring the circuit was available.

The invention of the ofMRI by Professor Lee is starting to enable such process. The new ofMRI approach utilizes the optogenetics technology to genetically modify specific target circuit element to make it sensitive to light for triggering (see figure) while non-invasive monitoring is performed through passband b-SSFP fMRI (pioneered by Professor Lee) that allows accurate monitoring of the causal circuit response in a non-invasive manner.

Her pioneering work was recently published in the *Journal Nature* this June and was also recognized by the NIH/NIBIB R00 Pathway to Independence Award and the 2010 Okawa Foundation Research Grant Award.

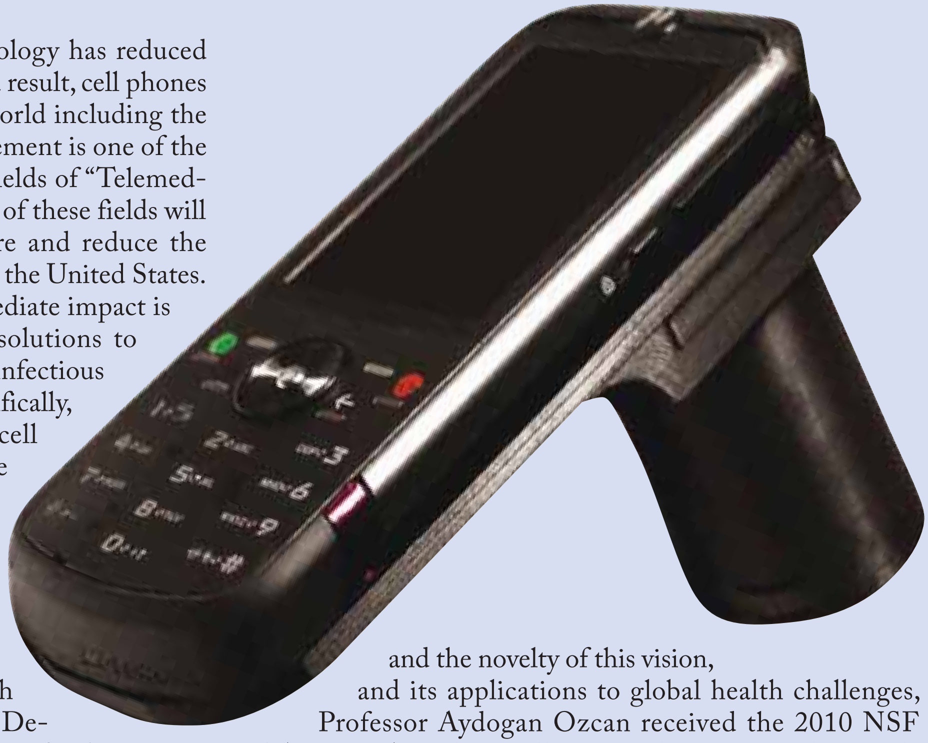


Optogenetic Functional Magnetic Resonance Imaging (ofMRI) technology holds great promise in analyzing the brain circuit.

NSF CAREER Award for Professor

Aydogan **Ozcan**

for Contribution to Telemedicine with Cellular Microscope

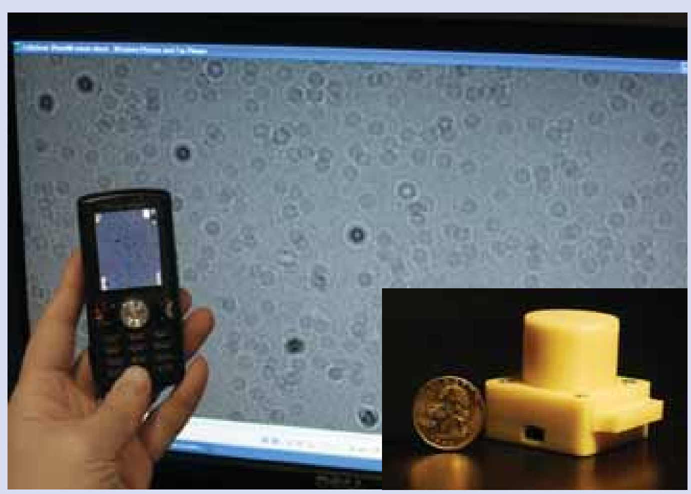


The cost of wireless cell phone technology has reduced significantly over the last decade. As a result, cell phones today are in use even in the developing world including the deserts of Africa. This impressive advancement is one of the central building blocks of the emerging fields of "Telemedicine" and "Wireless Health". The success of these fields will surely increase the quality of health care and reduce the insurance costs in developed countries like the United States. However, their most important and immediate impact is to provide breakthrough technological solutions to various global health problems including infectious diseases such as HIV, TB or malaria. Specifically, utilizing this advanced state of the art cell phone technology towards point-of-care diagnostics and/or microscopic imaging applications can offer numerous opportunities to improve health care especially in the developing world where medical facilities and infrastructure are extremely limited or even non-existant.

The focus of the Ozcan Research Group at UCLA Electrical Engineering Department is centered on this vision to create fundamentally new imaging and sensing architectures that can compensate in the digital domain for the lack of complexity of optical components by use of novel theories and numerical algorithms to address the immediate needs and requirements of Telemedicine for Global Health Problems.

With an innovative track record and a unique background spanning both electrical engineering and medicine, the Ozcan Research Group aims to initiate the seeds of an international center with a research focus on Smart Global Health Systems by merging the existing strengths of the Electrical Engineering Department and the rest of the campus.

As a recognition of the impact, significance and the novelty of this vision, and its applications to global health challenges, Professor Aydogan Ozcan received the 2010 NSF CAREER Award, as well as several major awards including NIH Director's New Innovator Award, Office of Naval Research (ONR) Young Investigator Award, IEEE Photonics Society Young Investigator Award, Okawa Foundation Award, Vodafone Americas Foundation Wireless Innovation Award, MIT's TR35 Award, National Geographic Emerging Explorer Award, and the Bill & Melinda Gates Foundation Grand Challenges Award.



A modified cell phone device with a lensfree holographic on-chip microscope. For more information: http://www.ee.ucla.edu/faculty-ozcan.htm.

Professor

Sudhakar **Pamarti**

Receives NSF CAREER Award

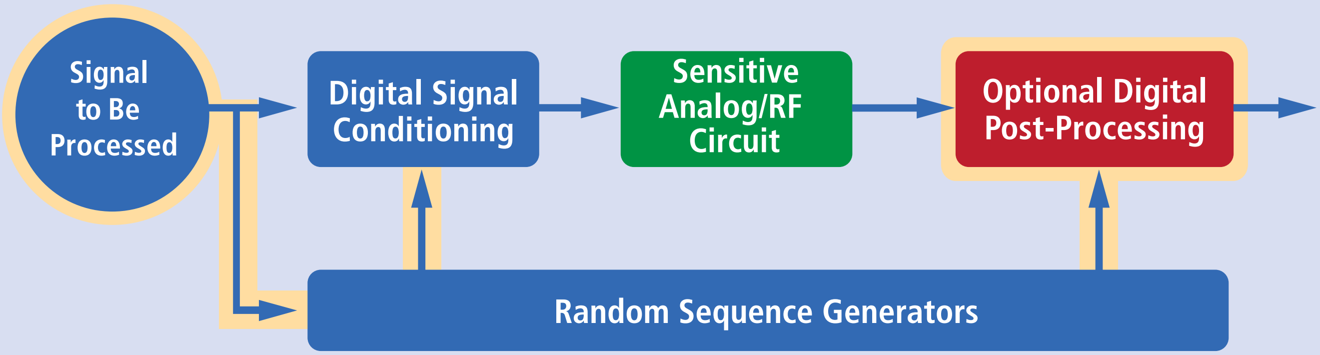
Professor Pamarti's CAREER Award recognizes his career development plan entitled Digital Signal Conditioning Techniques to Improve Integrated Circuit Performance. Professor Pamarti's research focuses on the development and the application of digital signal processing (DSP) techniques to overcome performance limitations in critical analog and radio frequency (RF) integrated circuits (ICs).

Analog and RF circuits remain performance bottlenecks in the vast majority of wireless communication, sensor network, health, and biotech applications. Somewhat surprising, this is a consequence of fabrication process scaling and Moore's law: the exponential growth of the capabilities of digital ICs has driven up the performance demands on the analog/RF circuits that operate at the boundaries of the physical and digital worlds. Traditional analog/RF IC design techniques, which rely on designer experience, intuition, and simulation-driven circuit optimization, are proving incapable of meeting these higher performance demands in the face of the increased variability in scaled processes.

Professor Pamarti's research develops a radically different, and arguably better approach to analog/RF IC design. He uses simple, error prone, analog circuit blocks, but relies on sophisticated signal processing techniques implemented in digital logic circuits to overcome analog circuit impairments and guarantees the desired performance. The overall system performance is determined by the sophistication of the signal processing techniques rather than analog/RF circuit optimization. This approach is naturally less sensitive to fabrication errors, process variability, and transistor non-linearity; and offers robust IC designs, better manufacturing yields, and shorter design cycles. Furthermore, the die area and power consumption costs of the added digital logic circuits are often negligibly small owing to the benefits of scaling.

For example, Professor Pamarti's research group has developed "digital signal conditioning" techniques that subtly alter the statistical properties of the analog/RF signals (being processed by the analog/RF circuit) according to an appropriate digital signal processing algorithm so the signals become insensitive to errors and non-linearity. The developed techniques target several key analog/RF circuit blocks described below:

- Wide bandwidth frequency synthesizers: These are crucial to newer communication applications, beam-forming radar, medical imaging ICs, and efficient power amplifier architectures. Professor Pamarti's students have demonstrated a 60 MHz bandwidth frequency synthesizer — a 20x improvement in bandwidth compared to prior art — based on two digital conditioning techniques.
- Efficient switching power amplifier architectures: Power amplifiers suffer from a fundamental tradeoff between efficiency and envelope dynamic range resulting in low average efficiencies and significant battery drain in portable communication devices. Professor Pamarti's students have developed and demonstrated in prototype hardware a digital delta-sigma modulation based technique to alleviate the tradeoff and maintain near constant efficiency over 12-15 dB of envelope dynamic range.
- High speed I/O: Multi-Gb/s chip-to-chip links, which are critical to most computing systems, suffer from pin underutilization, low aggregate bandwidth, and electromagnetic crosstalk. Professor Pamarti's students have demonstrated 16Gb/s links based on a Code Division Multiple Access (CDMA)-like signaling technique that offers 50% better pin utilization than prior art.



Digital signal conditioning techniques developed to render analog/RF signals insensitive to circuit imperfections.

Professor

Henry **Samueli**

Awarded the Prestigious 2010 UCLA Medal

The UCLA Medal is the highest honor bestowed by the University of California, Los Angeles. Created in 1979, the medal is awarded to those who have made truly extraordinary and distinguished contributions to their profession, to higher education, to society, and to the university.

Previous medal recipients include former Presidents Bill Clinton and Jimmy Carter; United Nations Secretary-General Ban Ki-moon; planetary physicist Carl Sagan; and others.

Since 1985 Dr. Samueli has been a professor in the Electrical Engineering Department at the University of California, Los Angeles, where he supervised advanced research programs in broadband communications circuits and digital signal processing, and published over 100 technical papers in these areas. He is widely recognized as one of the world's leading experts in the field. He is a named inventor in 59 U.S. patents.

Professor Henry Samueli is the co-founder of Broadcom, which is one of the world's leading semiconductor companies in the area of communications circuits. He has served in various capacities, including Co-Chairman, Chairman and Vice President of Research & Development. He currently serves as its Chief Technical Officer (CTO), responsible for driving the vision of Broadcom's research and development activities as well as helping coordinate corporate-wide engineering development strategies.

Dr. Samueli received all of his three degrees, B.S., M.S., and Ph.D., in Electrical Engineering at UCLA where he also serves as a faculty member in Electrical Engineering and co-chairs the HSSEAS Dean's Advisory Council.

Professor Henry Samueli Awards and Recognitions:

- 2010 UCLA Medal
- 2004 American Academy of Arts and Sciences
- 2003 National Academy of Engineering
- 2000 Fellow, IEEE

Distinguished Professor

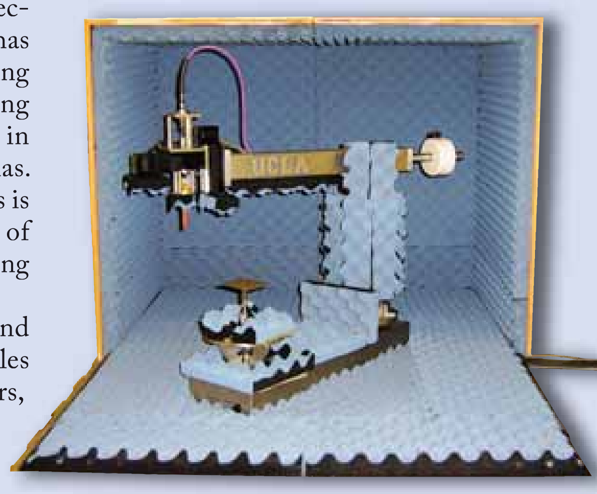
Yahya **Rahmat-Samii**

Receives the 2011 IEEE Electromagnetics Award

Distinguished Professor Yahya Rahmat-Samii, holder of the Northrop Grumman Chair in Electromagnetics and a member of the US National Academy of Engineering (NAE), received the 2011 IEEE Electromagnetics Award for his "fundamental contributions to reflector antennas, near-field measurements and diagnostics, antenna and human interactions, and optimization algorithms in electromagnetics." This is an IEEE-wide award and covers all fields of Electrical Engineering. Professor Rahmat-Samii has been a faculty member in Electrical Engineering at UCLA since 1989. He has had pioneering and groundbreaking research contributions in diverse areas of electromagnetics and antennas. The results of his novel research developments is utilized in billions of cell phones, millions of dish antennas and many NASA remote sensing and planetary missions.

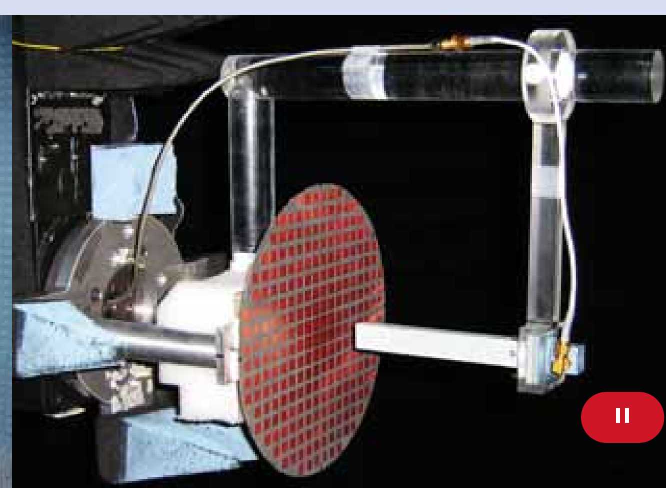
Professor Rahmat-Samii has authored and co-authored over 800 technical journal articles and conference papers, over 30 book chapters, four books and several patents. His co-authored books, *Electromagnetic Optimization by Genetic Algorithms*, *Electromagnetic Band Gap Structures in Antenna Engineering*, and *Implanted Antennas in Medical Wireless Communications* were the first ones appearing on these subjects. He was one of the inventors of the plane-polar and bi-polar planar antenna near-field measurement and diagnostic techniques, he pioneered the concept of reflector antenna shaping based on the orthogonal function expansions using physical optics diffraction methods, and for the first time he demonstrated the mathematical bases of the microwave holography diagnostic techniques for large reflector antennas. He was one of the major contributors in recognizing the importance of developing "internal" antennas for cell phones including understanding the effects of the head and hand interactions.

Professor Rahmat-Samii had pioneering contributions in effectively utilizing nature inspired optimization techniques in designing antennas for spaceborne, mobile platforms and medical applications. He was one of the originators of the spectral theory of diffraction in unifying existing methods on the electromagnetic high frequency asymptotic techniques. Many of his papers appeared on the cover pages of technical journals.



Professor Rahmat-Samii's pioneering research with antennas contributed to many advances in wireless communications, planetary and remote sensing missions, and bio-telemetry medical applications.

Professor Rahmat-Samii has an illustrious career and his research and teaching activities is recognized with the most distinguished prizes, awards and elected positions in electrical engineering.



Professor Ben Williams is

Closing the **Terahertz Gap**

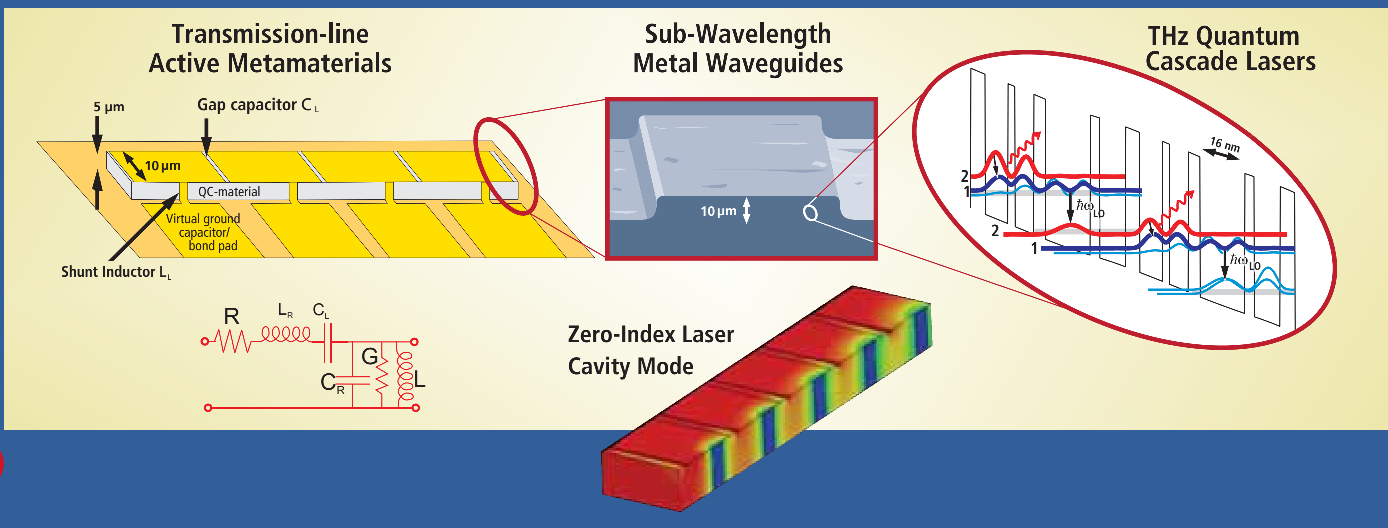
The Terahertz Devices and Intersubband Nanostructures group, led by Assistant Professor Ben Williams, is focused on the development of optoelectronic technology for the terahertz and mid-infrared electromagnetic spectral ranges. The terahertz range in particular (1-10 THz, λ~30-300 μm) is historically underdeveloped compared to neighboring RF and microwave ranges (longer wavelengths) and infrared ranges (shorter wavelengths) — hence closing this "terahertz gap" is motivated by the desire to make use of the entire electromagnetic spectrum. Although many advances have taken place in recent years, it remains difficult to generate, detect, and control radiation at these frequencies.

To respond to this challenge, one major thrust of the group is the development of compact and high-power semiconductor sources of terahertz radiation based upon engineering low-dimensional semiconductor heterostructures (i.e. quantum wells and quantum dots) to make "artificial molecules" with infrared and THz response. Laser sources based on these materials — known as quantum-cascade lasers — promise to enable applications in fields as diverse as chemical and biological sensing, security screening, explosive and drug detection, astrophysics and space science, medical imaging, nondestructive evaluation of materials, and short-range high-bandwidth communications.

To highlight one application, telescopes that are sensitive to terahertz frequencies are of critical importance to explore the structure and history of the universe, to understand how stars are born from dust clouds, and to identify the origins of biogenic molecules. Working in collaboration with semiconductor crystal growers from Northrop Grumman Aerospace Systems (Redondo Beach, CA), terahertz quantum-cascade lasers have been designed, fabricated, and demonstrated in this group at UCLA at a range of frequencies between 2.5-5 THz (wavelengths from 60-120 μm). If properly developed to improve their output power, operating temperatures and beam patterns, these lasers are candidates for local oscillators in future terahertz heterodyne telescopes.

A second focus of Professor Ben Williams' group is the engineering of novel electromagnetic materials and structures for the THz range. Recently, much attention has been given to so-called electromagnetic metamaterials that are constructed from dielectric, metallic, and plasmonic elements with sub-wavelength dimensions that can be engineered to provide properties not found in nature — such as negative refractive index, or optical magnetism. In collaboration with Professor Tatsuo Itoh's group, Professor Ben Williams is investigating the development of transmission-line metamaterials that can be integrated with THz quantum-cascade gain media. This approach not only can solve the problem of ohmic losses in such metamaterials, but will enable entirely new devices such as efficient laser cavities that exhibit zero index of refraction, highly directional THz antennas, sub-wavelength laser resonators, and materials and devices with dynamically tunable characteristics.

For example, Professor Williams' group has recently proposed a novel device — the zero-index quantum-cascade laser. Unlike a conventional laser cavity, which is based upon a standing wave confined by some form of reflection, the metamaterial laser cavity oscillates on what is essentially an LC circuit resonance. Under the proper conditions, this device can be coaxed to oscillate in a mode which uniformly and efficiently saturates the gain medium, thus potentially suppressing undesirable nonlinear effects such as spatial hole burning and multi-mode lasing. In the future, these techniques may lead to THz sources with improved spectral purity, low-power operation, radiative efficiency, beam-patterns, and integrated amplitude and frequency modulation.



Professor John Villasenor

Keeping Hardware **Secure**

Professor John Villasenor is leading a research effort in hardware security — an area that, despite its importance, has received much less attention than software security.

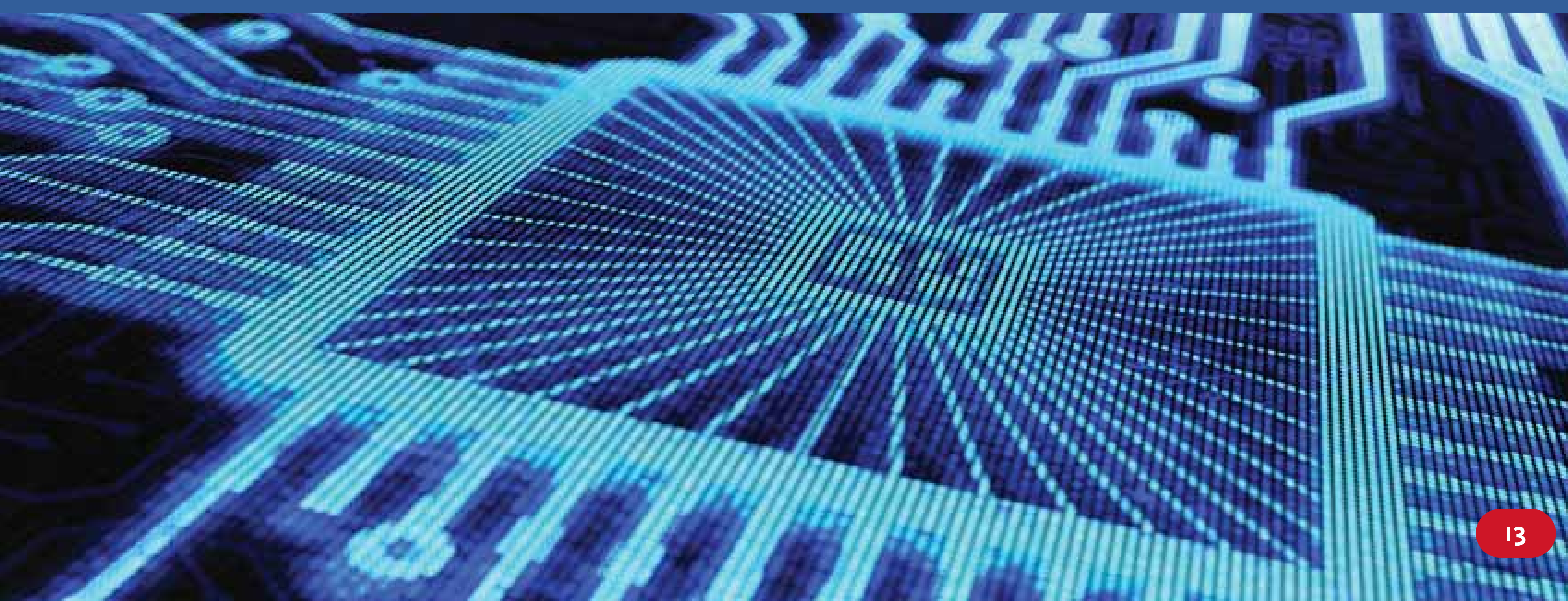
More than ever, the devices that are critical to everyday life, and to the larger infrastructure, are dependent on increasingly sophisticated integrated circuits (ICs).

Despite their small size, today's ICs can contain an enormous amount of functionality. The largest chips today contain upwards of a billion transistors, and this number continues to expand as manufacturing and design methods improve. Chips often incorporate designs drawn from companies located in many different countries, with hundreds or more engineers contributing to the process. The globalization of chip design brings many benefits in terms of shorter time to market for new products and lower costs to the consumer. However, it also creates a growing risk that malicious circuitry — a "Trojan horse" — could be embedded in a chip. The Trojan, upon being awakened, could cause the chip (and thus the device or product that contains it) to stop working. Or, the Trojan could work quietly in the background, sending confidential data to a different location. On a large scale, attacks such as these could have dramatic consequences.

While the potential threat posed by compromised hardware has received some attention in recent years, most efforts are directed at identifying any malicious circuitry prior to silicon deployment or at making sure circuits are never compromised in the first place. By contrast, Professor Villasenor has pioneered methods to equip chips with built-in defenses that enable instantaneous detection of and response to attacks in run time, as they occur. These methods were described in an article in the August, 2010 issue of *Scientific American*.

"We think of a chip with 2 billion transistors as being very large today — and it is —, but in 5, 10, 15 years, chips will be many times more complicated than they are today," explains Professor Villasenor. "It will become nearly impossible to ensure in advance that chips have no hidden malicious circuits. Instead, we'll need to have the equivalent of an onboard police force to keep an eye on things, and to restore order when things go wrong." Methods developed and experimentally verified in Professor Villasenor's laboratory include secure intra-chip communications techniques to ensure that a hardware attack cannot disable the flows of data within a chip, and architectures allowing circuitry that has been identified as compromised to be automatically replaced using configurable hardware within a chip. "Attempts to compromise hardware will be an unfortunate reality in the future," explains Professor Villasenor. "The good news is that using techniques we are developing, we can go a long way towards stopping them, or at least minimizing their impact."

Professor Villasenor's research includes a range of measures aimed at ensuring hardware security, including a Trojan-resistant system bus architecture suitable across a wide range of devices. The system detects malicious bus behaviors associated with a Trojan hardware attack, protects the system and system bus from them, and reports the malicious behaviors to the CPU. The use of this bus, associated with embedded software, is highly effective in reducing vulnerabilities without performance loss. Methods to ensure memory security and the integrity of functional blocks are also part of his research.



Alumni **Event**

Electrical Engineering Showcase Held in Los Altos Hills, CA.

On May 1st, 2010, the Electrical Engineering Department held its first Research Showcase and Luncheon hosted by Bruin Alumna Vera Elson '82, MSEE '85.

This event was attended by 40 industry leaders and UCLA engineering alumni. The purpose of this event was to highlight Electrical Engineering cutting-edge research and provide a networking opportunity with top faculty in the school.

Faculty Speakers included Asad Abidi, Dejan Markovic, Aydogan Ozcan, Ali Sayed, and John Villasenor.

Professor Ali Sayed, host Vera Elson, alumnus Charley Kline and professor Asad Abidi

Dejan Markovic, Vera Elson and Aydogan Ozcan

Alumni Vera Elson and Asad Madni

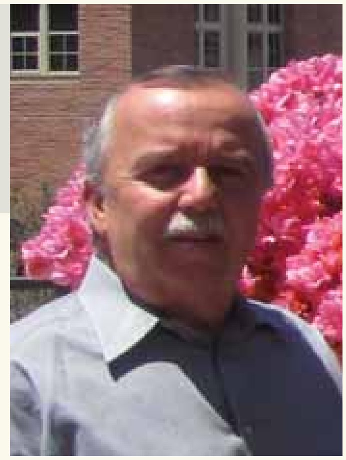
Alumnus Mark Gersh (Lockheed) and professor John Villasenor

Alumni Advisory Board

The mission of the Alumni Advisory Board is to provide critical and supportive advice to the UCLA Electrical Engineering Department in enhancing its leadership role in education and research.

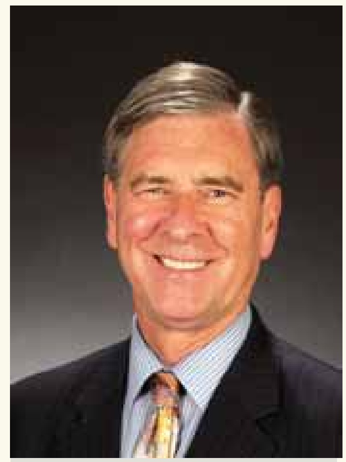
Leonard Bonilla
Retired
Raytheon

Asad Madni, EE AAB Chair
President and CEO (Retired)
BEI Technologies, Inc,



Vincent Gau
CEO
Gene Fluidics

Bob Green
Attorney
Christie, Parker, and Hale, LLP



David Doami
Director, Program Manager
Northrop Grumman

Bill Goodin
Director, Short Course & Technical Management Programs UCLA Extension

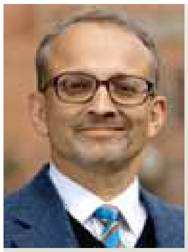
Sharon V. Hong
Systems Integration Specialist
Motorola

Dan Goebel
Senior Research Scientist
Jet Propulsion Laboratory

Sharon Black
Special Projects Program Director
Raytheon

Vicky Gih
Design Engineer & Product Lead
Northrop Grumman

Members of National Academies



Asad A. Abidi

National Academy of Engineering

Professor Asad A. Abidi has been with the Electrical Engineering Department since 1985. In 2007, he was inducted into the National Academy of Engineering for his contributions to the development of MOS integrated circuits for RF Communications. Prior to his tenure with the department, Abidi worked at Bell Laboratories, Murray Hill, NJ, as a member of the technical staff in the Advanced LSI Development Laboratory. He received a number of awards and honors throughout his career, including the 1988 TRW (now Northrop Grumman) Award for Innovative Teaching, the 1997 IEEE Donald G. Fink Award, presented for the most outstanding survey, review, or tutorial paper published in the IEEE transactions, journals, magazines, or in the proceedings during a given year, and the 2008 IEEE Donald O. Pederson Award in solid state circuits.

M. C. Frank Chang

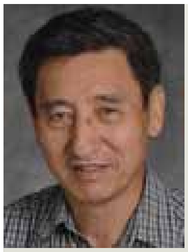
National Academy of Engineering

Professor Mau-Chung Frank Chang was elected to the National Academy of Engineering in 2008 for his contributions in development and commercialization of III-V-based heterojunction bipolar transistors (HBTs) and field-effective transistors (FETs) for RF wireless communications. Prior to joining UCLA, Professor Chang was the Assistant Director at Rockwell Science Center where he successfully developed and transferred AlGaAs/GaAs Heterojunction Bipolar Transistor (HBT) and BiFET (Planar HBT/MESFET) integrated circuits technologies from the research laboratory to the production line. The primary focus of his research has been the development of high-speed semiconductor devices, integrated circuits for RF and mixed-signal communication, and interconnect system applications. Professor Chang received the IEEE David Sarnoff Award (IEEE-wide Technical Field Award) in 2006 and the Pan Wen-Yuan Foundation Award in 2008.

Deborah Estrin

National Academy of Engineering

Professor Deborah Estrin, of the UCLA Computer Science and Electrical Engineering Departments, holds the Jonathan B. Postel Chair in Computer Networking in recognition of her ground-breaking research. Elected to the National Academy of Engineering in 2009, Estrin led the development and deployment of wireless sensing systems that provide real-time, multifaceted information about natural and urban environments. She created and directs the Center for Embedded Networked Sensing, a major multidisciplinary National Science Foundation research center, which brings together dozens of researchers from multiple universities and serves as a model for other federally funded centers. Estrin, who received numerous recognitions for her work, was selected as the first Athena Lecturer of the Association for Computing Machinery's (ACM) Committee on Women in Computing and was honored with the Women of Vision Award for Innovation from the Anita Borg Institute for Women and Technology. She is a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, the ACM and the IEEE.



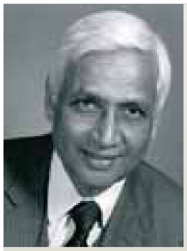
Tatsuo Itoh

National Academy of Engineering

Professor Itoh pioneered a research area in interdisciplinary electromagnetics beyond traditional electromagnetic engineering. Elected to the National Academy of Engineering in 2003, his citation reads: "For seminal contributions in advancing electromagnetic engineering for microwave and wireless components, circuits, and systems". In his early career, he developed a number of numerical methods for microwave problems. Based on one of these methods, he then developed the first CAD program package for design of E-plane filters for millimeter wave systems such as radio, radar, and remote sensors. More recently, his effort has been directed to coherently combining solid state devices and electromagnetic circuits for improved cost effectiveness and system performance. From this effort, the first global simulator for the RF frontend was developed, dealing with antennas, passive and active microwave circuits at the same time. He also created the Active Integrated Antenna scheme in which the antenna is not only a radiating element, but also serves as a circuit element for the RF front end, particularly at millimeter wave frequencies.

Stanley Osher
National Academy of Sciences

Professor Stanley Osher was elected to the National Academy of Sciences for "major contributions to algorithm development and applications in level set methods, high-resolution shock capturing methods, and PDE-based methods in imaging science." He has been at UCLA since 1976 and is Director of Special Projects at the Institute for Pure and Applied Mathematics. He is the co-inventor of level set methods for computing moving fronts, numerical methods for computing solutions to hyperbolic conservation laws and Hamilton-Jacobi equations, and total variation and other PDE-based image processing techniques. Dr. Osher was a Fulbright and Alfred P. Sloan Fellow, and received the NASA Public Service Group Achievement Award, the Japan Society of Mechanical Engineers Computational Mechanics Award, the SIAM Pioneer Prize, and the SIAM Kleinman Prize.

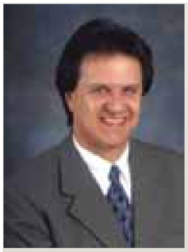


C. Kumar Patel
National Academy of Sciences,
National Academy of Engineering

Professor Patel holds a joint professorship with the Electrical Engineering and Physics Departments at UCLA. He made numerous seminal contributions in several fields, including gas lasers, nonlinear optics, molecular spectroscopy, pollution detection and laser surgery. He received numerous honors, including the National Medal of Science, for his invention of the carbon dioxide laser. He also received the Lomb Medal of the Optical Society of America, the Franklin Institute's Ballantine Medal, the Pake Prize of the American Physical Society, and the Coblentz Society's Coblentz Prize.

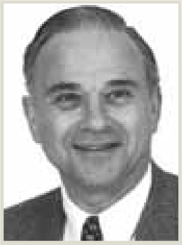
Henry Samueli
National Academy of Engineering

Dr. Henry Samueli was elected to the National Academy of Engineering in recognition of his "pioneering contributions to academic research and technology entrepreneurship in the broadband communications system-on-a-chip industry". Dr. Samueli has over 25 years of experience in the fields of digital signal processing and communications systems engineering. He is widely recognized as one of the world's leading experts in the field. He received his B.S., M.S. and Ph.D. degrees in electrical engineering from UCLA. Since 1985, Dr. Samueli has been a professor in the Electrical Engineering Department where he has supervised advanced research programs, and is also well known as the co-founder of Broadcom Corporation. In 2010, Professor Samueli received the UCLA Medal.



Yahya Rahmat-Samii
National Academy of Engineering

Professor Yahya Rahmat-Samii was elected to the National Academy of Engineering in 2008 for his pioneering contributions to the design and measurement of reflector and hand-held device antennas. Many of his design concepts are currently used in cell phones, planetary spacecraft, earth-observation satellites, and satellite dishes. Prior to joining UCLA Engineering, he was a Senior Research Scientist at NASA's Caltech Jet Propulsion Laboratory (JPL). He is a Distinguished Professor of Electrical Engineering and holds the Northrop Grumman Chair in Electromagnetics. His honors include the 2007 Chen-To Tai Distinguished Educator Award from the IEEE Antennas and Propagation Society; the 2005 International Union of Radio Science's Booker Gold Medal; the 2000 Antenna Measurement Techniques Association's Distinguished Achievement Award; the IEEE's Third Millennium Medal; a Distinguished Alumni Award from the University of Illinois ECE Department, Urbana-Champaign.



Jason Speyer
National Academy of Engineering

Professor Jason Speyer was elected to the National Academy of Engineering for "the development and application of advanced techniques for optimal navigation and control of a wide range of aerospace vehicles." He pioneered new optimal deterministic and stochastic control, team and differential game strategies, estimation, and model-based fault detection, identification, and reconstruction theories and algorithms, as well as matrix calculus of variations for the Apollo autonomous navigation system. He pioneered the development and mechanization of periodic optimal control with applications to aircraft fuel-optimal cruise and endurance. His efforts in differential carrier phase GPS blended with an inertial navigation system, was applied to formation flight for drag reduction, and achieved centimeter accuracy in flight tests. Dr. Speyer is a fellow of AIAA and IEEE (Life Fellow) and received the IEEE Third Millennium Medal as well as several AIAA Awards.

Center for Embedded Networked Sensing (CENS)

CENS
Center for Embedded Networked Sensing

CENS is a major research enterprise focused on developing wireless sensing systems and applying this revolutionary technology to critical scientific and societal pursuits. In the same way that the development of the Internet transformed our ability to communicate, the ever decreasing size and cost of computing components is setting the stage for detection, processing, and communication technology to be embedded throughout the physical world. By investigating fundamental properties of embedded networked sensing systems, developing new technologies, and exploring novel scientific and educational applications, CENS is a world leader in unleashing the tremendous potential these systems hold. The center is a multidisciplinary collaboration among faculty, staff, and students. CENS was established in 2002 as a National Science Foundation Science and Technology Center and is a partnership of UCLA, UC Riverside, UC Merced, USC, and Caltech. Electrical Engineering Professors Deborah Estrin, Mark Hansen, Jack W. Judy, William J. Kaiser, Gregory J. Pottie, Mani B. Srivastava, John D. Villasenor, and Kung Yao are active members of the Center.
http://www.cens.ucla.edu

BRAD FEINKNOPF

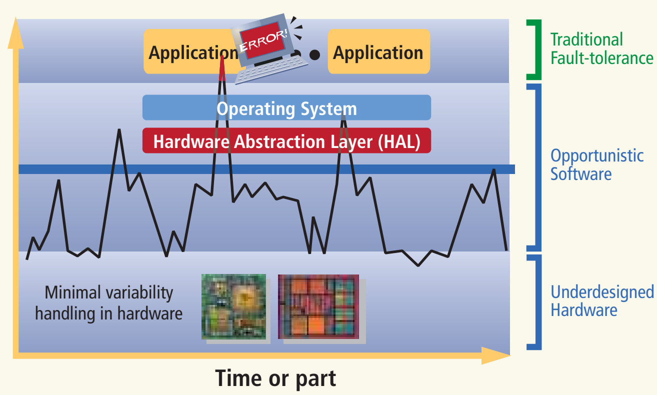
California NanoSystems Institute (CNSI)

CNSI

The **California NanoSystems Institute** is an integrated research facility located at UCLA and UC Santa Barbara. Its mission is to foster interdisciplinary collaborations in nanoscience and nanotechnology; train a new generation of scientists, educators and technology leaders; generate partnerships with industry; and contribute to the economic development and the social well-being of California, the United States and the world. The CNSI was established in 2000 with $100 million from the state of California. An additional $250 million of support has come from federal research grants and industry funding. CNSI members are drawn from the departments of biology, chemistry, biochemistry, physics, mathematics, computational science and engineering. This dynamic research setting has enhanced understanding of phenomena at the nanoscale and promises to produce important discoveries in health, energy, and the environment and information technology.
http://www.cnsi.ucla.edu

Expedition into Hardware-Variability-Aware Software

The **National Science Foundation** awarded $10 million to the research initiative "Hardware-Variability-Aware Software for Efficient Computing with Nanoscale Devices." The grant is part of the funding agency's Expeditions in Computing program, which rewards far-reaching agendas that "promise significant advances in the computing frontier and great benefit to society." Variability-aware computing systems would benefit the entire spectrum of embedded, mobile, desktop and server-class applications by dramatically reducing hardware design and test costs for computing systems while enhancing their performance and energy efficiency. The expedition's deputy director, Mani Srivastava, joins Lara Dolecek and Puneet Gupta from UCLA in a team of eleven researchers from various universities.

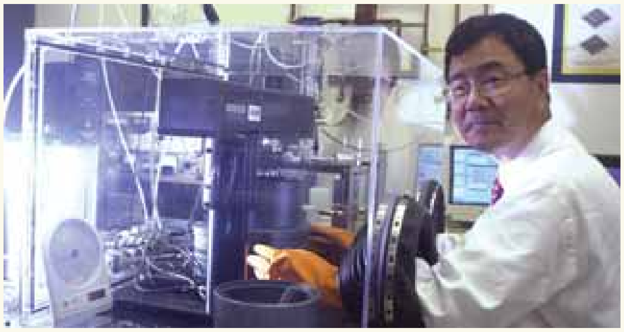


http://www.variability.org

FCRP Center on Functional Engineered Nano Architectonics (FENA)

FENA is part of the **Focus Center Research Program (FCRP)** initiated by the Semiconductor Research Corporation in an effort to expand pre-competitive, cooperative, long-range applied microelectronics research at US universities. The center, which was established in 2003, so far has received $38M, and is expected to receive an additional $15M through 2012. FENA aims to create and investigate new nano-engineered functional materials and devices, and novel structural and computational architectures for new information processing systems beyond the limits of conventional CMOS technology. FENA plays a key role in America's technology competitiveness as it addresses industry and DoD needs using the research university system, i.e. long-range, innovative applied research.

Western Institute of NanoElectronics (WIN)



The **Western Institute of Nanoelectronics** is multidisciplinary center that is among the world's largest spintronics efforts. WIN was established in 2006 and is headquartered at UCLA, led by Electrical Engineering Professor Kang Wang. The institute involves collaborations among nine national universities with 30 co-PIs. The institute's mission is to explore and develop advanced research devices, circuits and nanosystems with performance beyond conventional Complementary Metal Oxide Semiconductors (CMOS) devices. The Institute was established with funding totaling over $20 million which includes industrial support and UC Discovery matching grant. WIN industry partners are organized through the Nanoelectronics Research Initiative which includes semiconductor companies such as Intel, IBM, Texas Instruments, AMD, Globalfoundries, Freescale and Micron. In 2008, the National Institute of Standards and Technology (NIST), a federal technology agency, also joined the sponsoring industry consortia.

Center for Excellence in Green Nanotechnology

King Abdulaziz City for Science & Technology (KACST) in Saudi Arabia and the Henry Samueli School of Engineering and Applied Science, have signed an agreement that will establish a **Center of Excellence in Green Nanotechnology** to promote educational and research exchanges, as well as an agreement with UCLA for research in nanoelectronics and clean energy for the next 10 years.

From the UCLA side, the center is directed by Professor Kang L. Wang. KACST is both Saudi Arabia's national science agency and its national laboratories. At the signing ceremony, KACST was represented by Prince Turki, the organization's vice-president for research institutes.

The initial kick-off phase of $3.2 million will fund the center over three years in the following research areas:

- Nanostructures for high efficiency solar cells
- Patterned nanostructures for integrated active optoelectronics on silicon
- Carbon nanotube circuits

"I am very delighted that we have started a joint collaboration with UCLA on green nanotechnogy," said Prince Turki. "We view UCLA as a leading world institution in many fields, and nanotechnology in particular. This collaboration is part of KACST's programs to implement the National Science, Technology and Innovation plan for the Kingdom of Saudi Arabia. The plan calls for the Kingdom to join the technologically advanced industrialized nations by 2025. We are looking forward to expand our joint Center with other fields in the future."

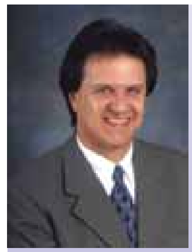
Faculty Awards

Assistant Professor Aydogan Ozcan has been selected to receive a 2010 **National Geographic Emerging Explorer Award.**

Professor Ozcan also received a **2010 NSF CAREER Award** from the National Science Foundation for his career development plan entitled "A new Telemedicine Platform using Incoherent Lensfree Cell Holography and Microscopy on a Chip."

Professor Aydogan Ozcan has been selected to receive a **2010 Netexplorateur 100 Award**, sponsored by the French government. Netexplorateur detects initiatives in terms of new uses of digital technology, and spreads knowledge and understanding of the related trends.

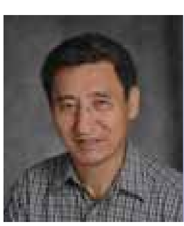
Assistant Professor Jin Hyung Lee has been selected to receive a **2010 Okawa Foundation Award**. The Okawa Prize is intended to pay tribute to and make public recognition of persons who made outstanding contributions to the research, technological development and business in the information and telecommunications fields, internationally.



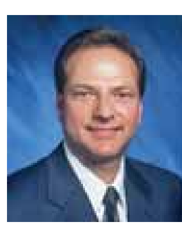
Professor Y. Rahmat-Samii was awarded the **2011 IEEE Electromagnetics Award** with the following citation: "For fundamental contributions to reflector antennas, near-field measurements and diagnostics, antenna and human interactions, and optimization algorithms in electromagnetics." The IEEE Electromagnetics Award is presented by the IEEE Board of Directors to an individual for outstanding contributions to electromagnetics in theory, application or education.

Assistant Professor Sudhakar Pamarti receives **2010 NSF CAREER Award** from the National Science Foundation. Professor Pamarti's award recognizes his career development plan entitled "Digital Signal Conditioning Techniques to Improve Integrated Circuit Design Performance." Professor Pamarti joined the department in 2005. His research focuses on the design of highly integrated wireless and wireline communication systems with particular emphasis on lowering their cost and power consumption. His work involves the design, silicon IC implementation, and verification of mixed-signal blocks which perform critical communication system tasks such as data conversion, frequency synthesis, clock synchronization, and channel equalization.

Assistant Professor Puneet Gupta has been selected to receive the **2010 ACM/SIGDA Outstanding New Faculty Award**. The award recognizes a junior faculty member early in his/her academic career who demonstrates outstanding potential as an educator and/or researcher in the field of electronic design automation. While prior research and/or teaching accomplishments are important, the selection committee especially considers the impact that the candidate has had on her or his department and on the EDA field during the initial years of their academic appointment. The award is presented annually at the Design Automation Conference, and currently consists of a $1,000 award to the faculty member, along with a citation. The award recognizes his career development plan entitled "Digital Signal Conditioning Techniques to Improve Integrated Circuit Design Performance."



Professor Tatsuo Itoh has been awarded the **2009 EuMA Oustanding Career Award** by the European Microwave Association.



Professor Henry Samueli has been awarded the prestigious **2010 UCLA Medal** for his contribution to science, education. and society as a philantropist.

Student Awards 2010

These awards are given to students for their academic excellence and contributions to the Department and the School.

The 2010 Outstanding Bachelor of Science Award in Electrical Engineering

Karan Kartik Mehta,
B.S. in Spring 2010

Outstanding Master of Science Award in Electrical Engineering

Aashish Pant,
Spring 2010 (Professor Puneet Gupta, Advisor)

Vaibhav Pradeep Karkare, Fall 2009 (Professor Dejan Markovic, Advisor)

Outstanding Doctor of Philosophy Award in Electrical Engineering

Thomas Schmid,
Fall 2009
(Professor Mani Srivastava, Advisor)

The Christina Huang Memorial Prize

Emily Sam Liu,
B.S. in Spring 2010

Outstanding M.S. Award recipients Aashish Pant and Vaibhav Karkare with their advisors Professor Dejan Markovic and Puneet Gupta

Award recipients with faculty advisors: Aashish Pant, Professor Puneet Gupta, Vaibhav Karkare, Professor Dejan Markovic, Karan Mehta, and Emily Liu (above)

Engineering Achievement Award for Student Welfare

Emily Sam Liu,
B.S. in Spring 2010

Jia Yin Seo,
B.S. in Spring 2010

Derek Wung,
B.S. in Spring 2010

Professor Lieven Vandenberghe with Christina Huang Memorial Prize recipient Emily Liu

The Electrical Engineering Department

Faculty and Staff

Ladder Faculty	45 FTEs
Courtesy Appointments	9
Emeriti Faculty	13
Adjunct	5
Lecturers	13
Staff	42

Recognitions

Society Fellows	33
NAE Members	7
NAS Members	2
National Medal of Science	1

Research Facilities

Laboratories and Research Groups: 37

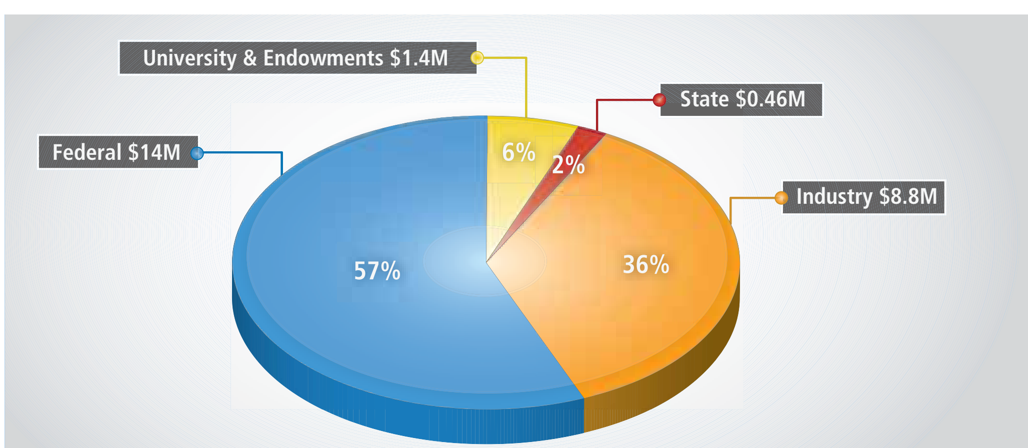
Space: 103,283 square feet

Department Contributes to Nine Research Centers

California NanoSystems Institute (CNSI)
Center for Embedded Networking Sensing (CENS)
Center for Excellence in Green Nanotechnology
Center for High Frequency electronics (CHFE)
Center for Systems, Dynamics and Controls (SyDyC)
Functional Engineered Nano Architectonics Focus Center (FENA)
Institute for Cell Mimetic Space Exploration (CMISE)
Nanoelectronics Research Center (NRC)
Western Institute of Nanotechnology (WIN)

Research Funding 2009-2010:

24.5M

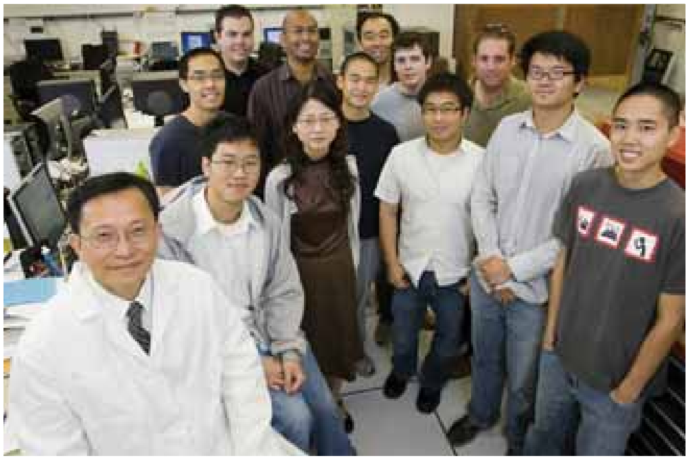


Undergraduate Students

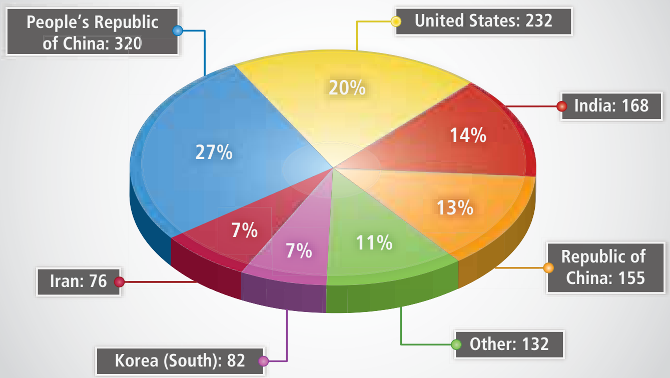
Students Enrolled	758
Applicants	1052
Admitted	516
New Students Enrolled	199
Average Freshman GPA	3.83

Graduate Students

Students Enrolled	381
Applicants	1165
Admitted	330
New Students Enrolled	98
Average Incoming GPA	3.62



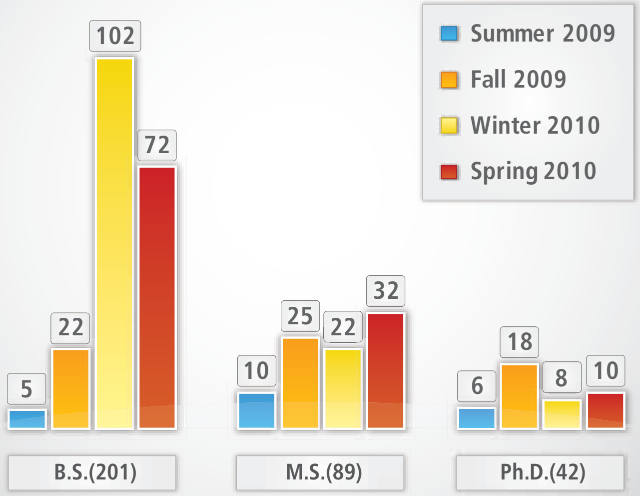
Graduate Applicants for Fall 2009



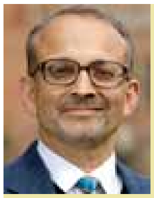
Fellowships Received by Electrical Engineering Graduate Students

Departmental Fellowships	$523,363
Non-Resident Tuition Support for Teaching Assistants	$186,124
Dean's GSR Support	$147,525
Henry Samueli Partial Fellowships	$125,627
Dissertation Year Fellowships	$116,905
Faculty Unrestricted Fellowships	$107,816
Clean Green IGERT Training Funds	$96,349
Ph.D. Preliminary Exam Top Score Fellowships	$56,769
Dean's Fellowship & Camp Funds	$46,509
Chancellor's Prize	$10,000
Malcolm R. Stacey Fellowship	$4,000
Conference Travel Funds	$1,200
TOTAL	**$1,422,187**

Degrees Conferred in 2009-2010



Circuits and Embedded Systems



Asad A. Abidi,
Professor
Ph.D., University of California, Berkeley, 1981

CMOS RF design, high speed analog integrated circuit design,data conversion, and other techniques of analog signal processing.

- National Academy of Engineering, 2007
- Fellow, IEEE, 1996

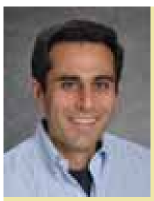
Danijela Cabric,
Assistant Professor
Ph.D., University of California, Berkeley, 2007

Wireless communications system design; Cognitive radio net- works; VLSI architectures of signal processing and digital communication algorithms; Performance analysis and experiments on embedded system platforms.

M.C. Frank Chang,
Professor and Chairman
Ph.D., National Chiao-Tung University, 1979

High speed electronics including ultra high speed frequency devices and integrated circuits for radio, radar and imaging system applications.

- National Academy of Engineering, 2008
- Fellow, IEEE, 1996



Babak Daneshrad,
Professor
Ph.D., University of California, Los Angeles, 1993

Digital VLSI circuits: wireless communication systems, high-performance communications integrated circuits for wireless applications.

Deborah Estrin,
Professor
Ph.D., Massachusetts Institute of Technology, 1985

Wireless sensor networks, environmental monitoring, participatory mobile sensing.

- National Academy of Engineering Member, 2009
- National Academy of Arts and Sciences, 2007
- Fellow, IEEE, 2004
- Fellow, AAAS, 2001
- Fellow, ACM, 2000

Puneet Gupta,
Assistant Professor
Ph.D., University of California, San Diego, 2007

Manufacturing, device, circuit and CAD techniques to enable design aware manufacturing and manufacturing aware design. Test stucture design for generating abstracted process and variation models. Techniques for leakage power modeling and reduction.

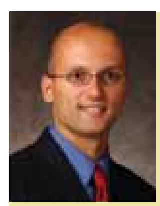
Lei He,
Professor
Ph.D., University of California, Los Angeles, 1999

Modeling and simulation, programmable logic and reconfigurable computing, and embedded and cyber-physical systems for applications such as health care, electric vehicle and smart grid.

William J. Kaiser,
Professor
Ph.D., Wayne State University, 1984

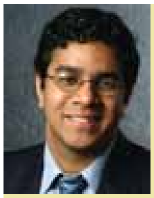
Development of distributed networked, embedded computing for linking the Internet to the physical world: applications include distributed systems for factory automation, biomedical research, health care, space science, security, and defense.

- Fellow, American Vacuum Society, 1994



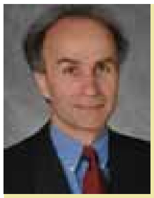
Dejan Markovic,
Assistant Professor
Ph.D., University of California, Berkeley, 2006

Power/area-efficient digital integrated circuits, VLSI architectures for wireless communications, optimization methods and supporting CAD flows.



Sudhakar Pamarti,,
Assistant Professor
Ph.D., University of California, San Diego, 2003

Mixed-signal IC design, signal processing and communication theory, especially the design of highly integrated wireless and wireline communication systems with particular emphasis on lowering cost and power consumption; design, silicon IC implementation, and verification of mixed-signal blocks.



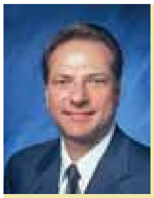
Behzad Razavi,
Professor
Ph.D., Stanford University, 1992

Analog, RF, and mixed-signal integrated circuit design, dual-standard RF transceivers, phase-locked systems and frequency synthesizers, A/D and D/A converters, high-speed data communication circuits.

- Fellow, IEEE, 2003

Vwani Roychowdhury,
Professor
Ph.D., Stanford University, 1989

Models of computation: parallel systems, quantum information processing, nanoscale and molecular electronics, statistical algorithms for large-scale information processing, combinatorics and complexity and information theory, bioinformatics, cryptography.



Henry Samueli,
Professor
Ph.D., University of California, Los Angeles, 1980

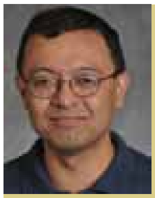
Digital signal processing, communications systems engineering, and CMOS integrated circuit design for applications in highspeed data transmission systems.

- American Academy of Arts and Sciences, 2004
- National Academy of Engineering, 2003
- Fellow, IEEE, 2000

Majid Sarafzadeh,
Professor
Ph.D., University of Illinois at Urbana-Champaign, 1987

Embedded and reconfigurable computing; VLSI CAD; design and analysis of algorithms.

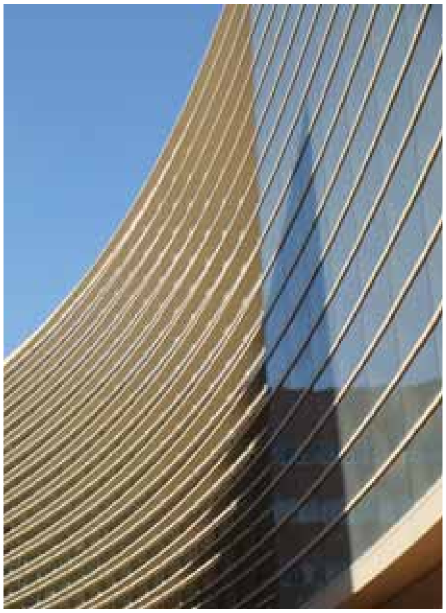
- Fellow, IEEE, 1996

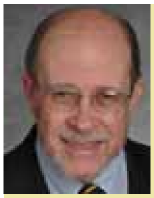


Mani B. Srivastava,
Professor and Vice Chair
Ph.D., University of California, Berkeley, 1992

Mobile and multimedia networked computing systems, design and synthesis of DSP systems, and low-power systems.

- Fellow, IEEE, 2008





Alan N. Willson, Jr.,
Professor
Ph.D., Syracuse University, 1967

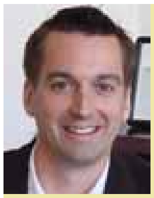
Theory and application of digital signal processing including VLSI implementations, digital filter design, nonlinear circuit theory.

- Fellow, IEEE, 1996

Chih-Kong Ken Yang,
Professor and Area Director
Ph.D., Stanford University, 1998

High-speed data and clock recovery circuits for large digital systems, low-power, high-performance functional blocks and clock distribution for high-speed digital processing, and low-power high-precision capacitive sensing interface for MEMS.

Physical and Wave Electronics



Robert Candler,
Assistant Professor
Ph.D., Stanford University, 2006

MEMS and NEMS devices, micro/nanoscale technology development, and the interface of physical microsystems with biology.

Chi On Chui,
Assistant Professor
Ph.D., Stanford University, 2004

Heterostructure semiconductor devices and technology involving the application of novel device concepts and fabrication techniques to explore the quantum and strain effects at the nanoscale.

Warren Grundfest,
Professor
M.D., Columbia University, 1980

Lasers for minimally invasive surgery, magnetic resonance-guided interventional procedures, laser lithotripsy, micro-endoscopy, spectroscopy, photodynamic therapy, optical technology, biologic feedback control mechanisms.

- Fellow, SPIE, 1996
- Fellow, American Institute of Medical & Biologic Engineers, 1996

Diana Huffaker,
Associate Professor
Ph.D., University of Texas at Austin, 1994

Directed and self-assembled nanostructure solid-state epitaxy, optoelectronic devices including solar cells and III-V/Si photonics.

- Fellow, IEEE, 2008

Tatsuo Itoh,
Professor
Ph.D., University of Illinois at Urbana-Champaign, 1969

Microwave and millimeter wave electronics, guided wave structures, low power wireless electronics, integrated passive components and antennas.

- National Academy of Engineering,
- 2003 Fellow, IEEE, 1982

Bahram Jalali,
Professor
Ph.D., Columbia University, 1989

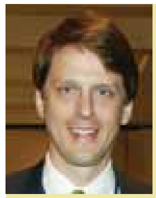
RF photonics, fiber optic integrated circuits, and Datacom systems.

- Fellow, Optical Society of America, 2004
- Fellow, IEEE, 2003

Chandrashekar Joshi,
Professor
Ph.D., Hull University, England, 1979

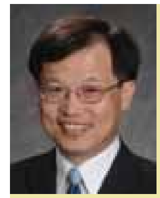
Laser fusion, laser acceleration of particles, nonlinear optics, high-power lasers, plasma physics.

- Fellow, IEEE, 1993
- Fellow, Institute of Physics (U.K.), 1998
- Fellow, American Physical Society, 1990



Jack W. Judy,
Associate Professor
Ph.D., University of California, Berkeley, 1996

MEMS, microsensors, micro-actuators, microsystems and micromachining; magnetism and magnetic materials; neuro- engineering and neuro-silicon interfaces; distributed sensors, actuators, and information.



Jia-Ming Liu,
Professor
Ph.D., Harvard University, 1982

Nonlinear optics, ultrafast optics, semi-conductor lasers, photonic devices, optical wave propagation, nonlinear laser dynamics, chaotic communications, chaotic radar, nanophotonic imaging, and biophotonics.

- Fellow, IEEE, 2008
- Guggenheim Fellow, 2006
- Fellow, American Physical Society, 2003
- Fellow, Optical Society of America, 1990

Warren Mori,
Professor
Ph.D., University of California, Los Angeles, 1987

Laser plasma interactions, advanced accelerator concepts, advanced light sources.

- Fellow, IEEE, 2007
- Fellow, American Physical Society, 1995

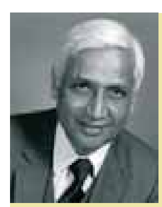
Christoph Niemann,
Assistant Professor
Ph.D., Massachusetts Institute of Technology, 1985

Laser-plasma interactions, high-energy density physics, and inertial confinement fusion.

Aydogan Ozcan,
Assistant Professor
Ph.D., Stanford University, 2005

Photonics and its applications to nano and bio-technology.

- Wireless Innovation Competition Award, 2009
- IEEE LEOS Young Investigator Award, 2009

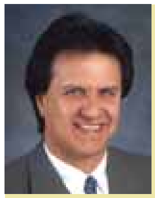


C. Kumar Patel,
Professor
Ph.D., Stanford University, 1961

Condensed matter physics, especially the structure and dynamics of “interesting systems”, broadly defined; spectroscopic techniques and detection methods; development of new laser systems.

- National Medal of Science, 1996
- National Academy of Engineering, 1978
- Fellow, IEEE, 1975
- National Academy of Sciences, 1974

Physical and Wave Electronics



Yahya Rahmat-Samii,
Professor
Ph.D., University of Illinois at Urbana-Champaign, 1975

Satellite, personal communications, microstrip, fractal, remote sensing, and radio astronomy antennas; electromagnetic bandgap structures; computational and optimization techniques, measurement and diagnostic techniques.

- National Academy of Engineering, in 2009 Fellow,
- IEEE, 1985

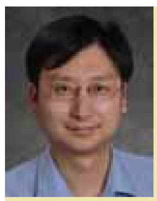
Oscar M. Stafsudd,
Professor
Ph.D., University of California, Los Angeles, 1967

Quantum electronics, especially IR lasers and nonlinear optics; solid-state IR detectors.

Kang L. Wang,
Professor
Ph.D., Massachusetts Institute of Technology, 1970

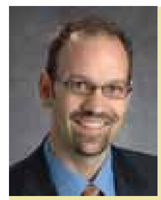
Nanoelectronics and optoelectronics, MBE and superlattices, microwave and millimeter electronics/optoelectronics, quantum computing.

- Fellow, IEEE, 1992



Yuanxun (Ethan) Wang,
Asociate Professor
Ph.D., University of Texas at Austin, 1999

High performance antenna array and microwave amplifier systems for wireless communication and radar; numerical modeling techniques; fusion of signal processing and circuit techniques in microwave system design.



Benjamin Williams,
Assistant Professor
Ph.D., Massachusetts Institute of Technology, 2003

Quantum cascade lasers in the terahertz frequency range, and the development of terahertz components based on sub-wavelength dimension for use in beam control, sensing, and imaging. Development of inter-subband and inter-sublevel based devices in low-dimensional nanostructures for electronic and optoelectronic applications.

Jason C.S. Woo,
Area Director and Vice Chair
Ph.D., Stanford University, 1987

Solid state technology, CMOS and bipolar device/circuit optimization, novel device design, modeling of integrated circuits, VLSI fabrication.

- Fellow, IEEE, 2005

Signals and Systems

Abeer Alwan,
Professor and Area Director
Ph.D., Massachusetts Institute of Technology, 1992

Speech processing, acoustic properties of speech sounds with applications to speech synthesis, recognition by machine and coding, hearing aid design, digital signal processing.

- Fellow, Acoustical Society of America, 2003

A. V. Balakrishnan,
Professor
Ph.D., University of Southern California, 1954

Laser beam distortion in atmospheric turbulence, control design for smart structures, and flight systems applications of adaptive control, nonlinear aeroelasticity, and wind power.

- Life Fellow, IEEE, 1996

Paganiotis Christofides,
Professor
Ph.D., University of Minnesota, 1996

Process control, dynamics and optimization, computational modeling and simulation of complex systems, and mathematics with the central objective of development of novel methods for the systematic and rigorous solution of complex process control and systems.

Lara Dolecek,
Assistant Professor
Ph.D., University of California, Berkeley, 2007

Information and probability theory, graphical models, combinatorics, statistical algorithms and computational methods with applications to high-performance complex systems for data processing, communication, and storage.

Suhas Diggavi,
Professor
Ph.D., Stanford University, 1998

Information theory, wireless networks, and signal processing. His current work is in cooperative information flow over wireless networks; network data compression; network secrecy; and large scale data analysis algorithms.

Mark Hansen,
Associate Professor
Ph.D., Massachusetts Institute of Technology, 1992

Statistical analysis of large complex data. Statistical methods for embedded sensing. Streaming data analysis. Text mining and information retrieval. Information theory and its applications to statistics.

- Fellow, SPIE, 1996
- Fellow, American Institute of Medical & Biologic Engineers, 1996

Alan J. Laub,
Professor
Ph.D., University of Minnesota, 1974

Numerical linear algebra, numerical analysis, high-end scientific computation, and computer-aided control system design, especially algorithms for control and filtering.

- Fellow, IEEE, 1986

Jin Hyung Lee,
Assistant Professor
Ph.D., Stanford University, 2004

Neural information processing and plasticity; Advanced imaging techniques for biomedical applications, neurosciences and neural-engineering; Magnetic Resonance Imaging (MRI); Development of novel image contrast strategies; Alternative image acquisition, reconstruction, and processing techniques.

Signals and Systems

Stanley Osher,
Professor
Ph.D., Courant Institute, New York University, 1966

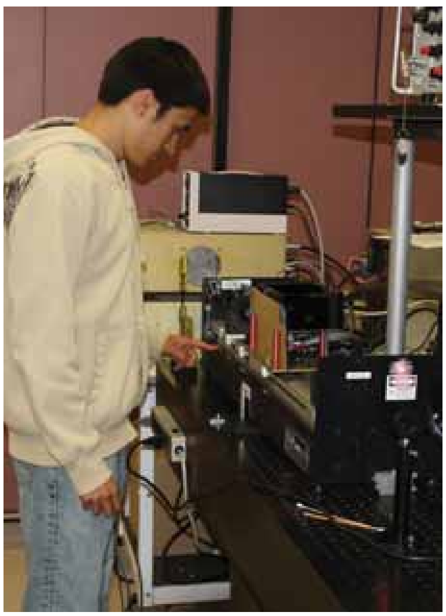
Innovative numerical methods for applications ranging from image science to control to electromagnetics to computational physics and beyond.

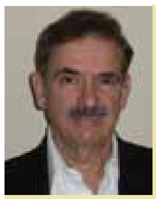
- National Academy of Sciences, 2005

Gregory J. Pottie,
Professor
Ph.D., McMaster University, 1988

Communication systems and theory, with applications to personal communications, channel coding, and wireless sensor networks.

- Fulbright Scholar, 2009
- Fellow, IEEE, 2005

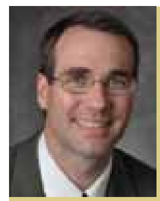




Izhak Rubin,
Professor
Ph.D., Princeton University, 1970

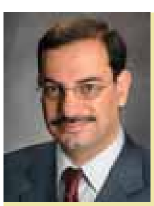
Telecommunications and computer communications sys- tems/networks; mobile wireless, optical, multimedia IP, ATM, satellite, and CATV networks; queueing systems, C3 systems/networks, network simulations and analysis, traffic modeling/engineering.

- Fellow, IEEE, 1987



Richard D. Wesel,
Professor and Associate Dean
Ph.D., Stanford University, 1996

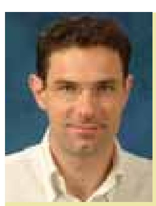
Communication theory with a particular interest in coded modulation including trellis codes and turbo codes for applications including mobile wireless communication systems, multiple antenna systems, and satellite communication systems.



Ali H. Sayed,
Professor
Ph.D., Stanford University, 1992

Adaptive and statistical signal processing, bio-inspired cognition, distributed processing, filtering and estimation, signal processing for communications, adaptive and wireless networks, algorithms for large-scale structured computations.

- Fellow, IEEE, 2001



Stefano Soatto
Professor
Ph.D., Caltech, 1996

Shape analysis, motion analysis, visual textures, image analysis and processing, nonlinear system theory.

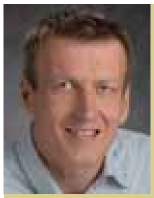
Jason Frank Speyer,
Professor
Ph.D., Harvard University, 1968

Stochastic and deterministic optimal control and estimation with application to aerospace systems; guidance, flight control, and flight mechanics.

- National Academy of Engineering, 2005
- Life Fellow, IEEE
- Fellow, AIAA, 1985

Paulo Tabuada,
Assistant Professor
Ph.D., Technical University of Lisbon, Portugal, 2002

Design of networked embedded control systems. Modeling, analysis and design of discrete-event, timed and hybrid systems. Hierarchical and distributed control design, geometric and algebraic control theory for nonlinear and Hamiltonian control systems, categorical systems theory.



Lieven Vandenberghe,
Professor and Vice Chair
Ph.D., Katholieke Universiteit, Leuven, Belgium, 1992

Optimization in engineering, applications in systems and control, circuit design, and signal processing.

Mihaela van der Schaar,
Professor
Ph.D., University of Technology, Eindhoven, 2001

Theory and design of novel algorithms, standards and systems for multimedia coding, processing and ubiquitous communication over Internet and wireless networks.

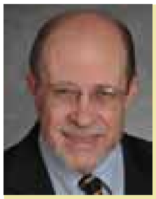
John D. Villasenor,
Professor
Ph.D., Stanford University, 1989

Methods, technologies, and systems used to capture information in the world around us, convert it into digital form and move it efficiently and securely from one place to another.

Kung Yao,
Professor
Ph.D., Princeton University, 1965

Communication theory, signal, acoustic, and array processing, wireless communication systems, sensor networks, chaos system theory, and VLSI and systolic algorithms and architectures.

- Fellow, IEEE, 1994



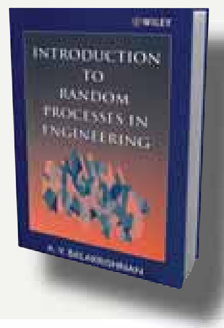
Alan N. Willlson, Jr.,
Professor
Ph.D., Syracuse University, 1967

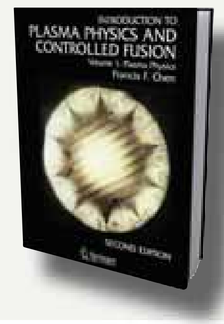
Theory and application of digital signal processing including VLSI implementations, digital filter design, nonlinear circuit theory.

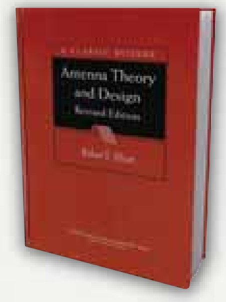
- Fellow, IEEE, 1996

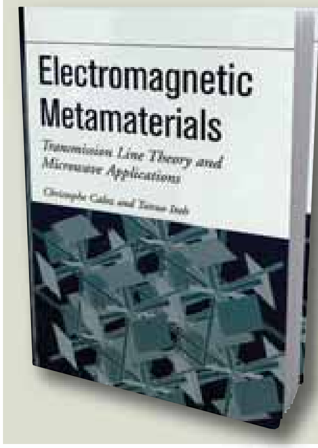
Books by Faculty

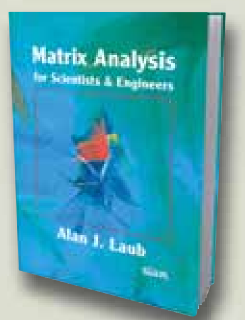
Numerous textbooks on graduate and undergraduate instruction are authored by our electrical engineering faculty. These are samples of the publications.

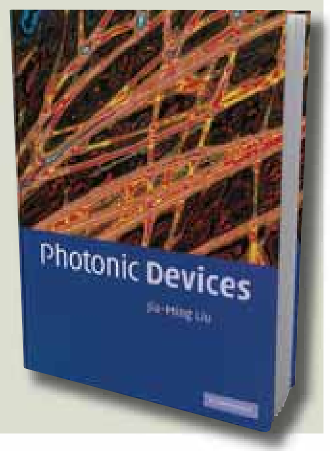


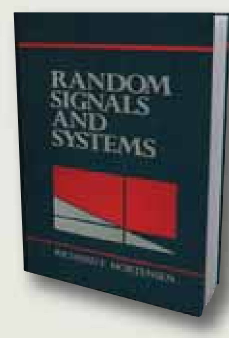


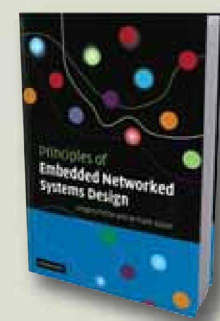


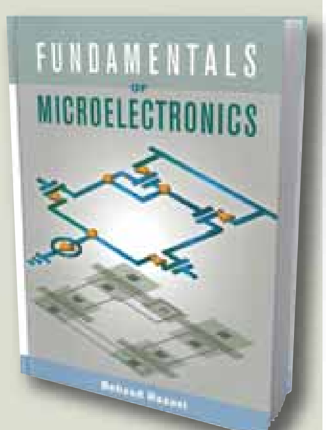


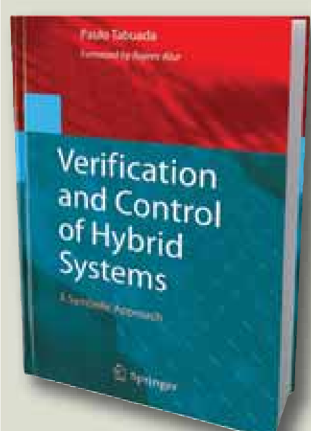


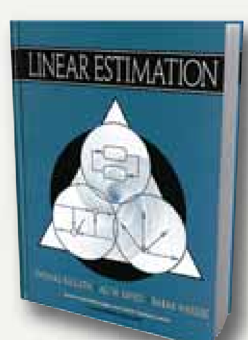


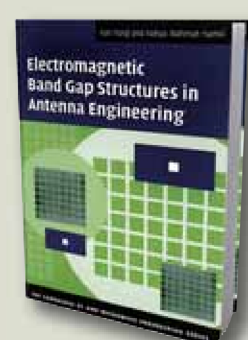


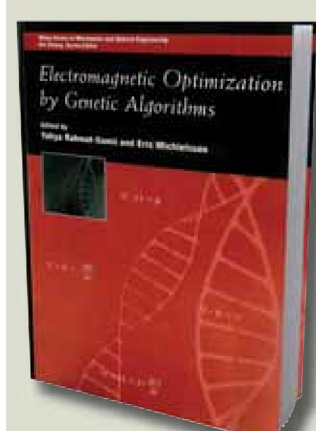












Administration

M.C. Frank Chang, *Department Chairman*
Jason C.S. Woo, *Vice-Chair, Industry Relations*
Mani B. Srivastava, *Vice-Chair, Graduate Affairs*
Lieven Vandenberghe, *Vice-Chair, Undergraduate Affairs*

Department Committees

E. Wang, *Director, Center for High-Frequency Electronics*
Robert Candler, *Director, Nano-Electronics Research Facility*
Alan Laub, *Chair, Tenure Committee*
Behzad Razavi, *Chair, Recruitment Committee*
Chih-Kong Ken Yang, *Chair, Non-Tenure Committee*
Jia-Ming Liu, *Chair, Courses and Curriculum Committee*

ABET Committee

Abeer A. Alwan, *Professor and Area Director*
M.C. Frank Chang, *Department Chairman*
Lieven Vandenberghe, *Professor and Vice-Chair*
Jason C.S. Woo, *Professor and Area Director*
Chi-Kong Ken Yang, *Professor and Area Director*

Industry Affiliates Program

The Electrical Engineering Department is dedicated to initiating and forging partnerships with industry, in which both the school and the companies involved benefit from the exchange of technology innovations and talent. The Industrial Affiliates Program (IAP), initiated in 1981, provides a variety of services that include:

- Nurturing the talent pipeline between UCLA and IAP members
- Providing access to UCLA intellectual capital
- Exploring collaborative research opportunities
- Providing access to state-of-the-art research facilities
- Enhancing industry visibility on campus

The department also serves as an invaluable consulting resource to our affiliate members. In turn, a company's participation in IAP provides essential program enhancement and aid to students with a portion of the membership fees being applied towards laboratory, instructional and other equipment needs. More details are available at the IAP website: http://www.ee.ucla.edu/Industry-home.htm.

Our Thanks to Affilate Members for Their Support

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Ali H. Sayed	*Professor*
Jacquelyn T. Trang	*Department Administrator*

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Deeona Columbia	*Director of Graduate Student Affairs*
Rose LaMountain	*Faculty Support*
Don Liebig	*UCLA Photographer*

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Professor Tatsuo Itoh	
Assistant Professor Jin Hyung Lee	
Professor Aydogan Ozcan	
Professor Sudhakar Pamarti	
Professor Yahya Rahmat-Samii	
Professor Ben Williams	
Professor John Villasenor	
Salvador Rivas	*Director, Industry Relations*
Doug Ramsey	*Professor, UC San Diego*

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Harue Suzuki	*Director of Human Resources*
Sylvia Abrams	*Principal Accountant in the School of Engineering*

Annual Report 2009-2010

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University of California
Los Angeles, CA 90095
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UCLA Engineering
HENRY SAMUELI SCHOOL OF
ENGINEERING AND APPLIED SCIENCE
Birthplace of the Internet