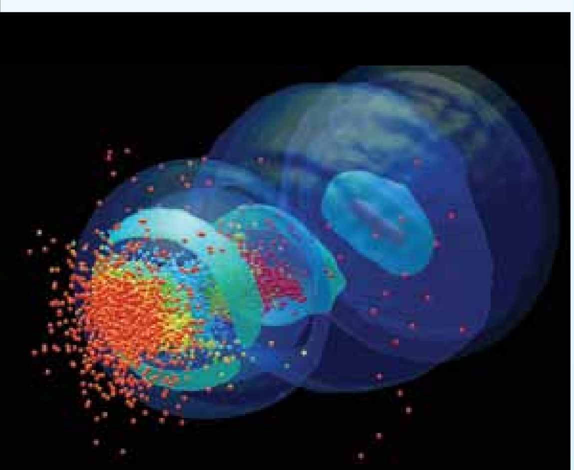
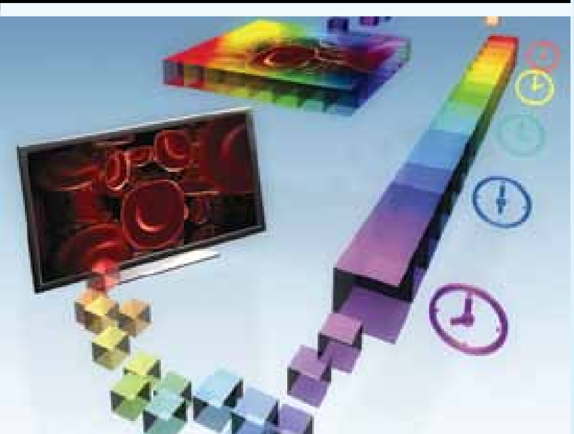


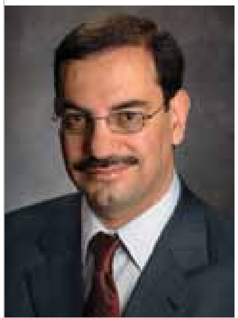


HENRY SAMUELI SCHOOL OF ENGINEERING AND APPLIED SCIENCE

UCLA ELECTRICAL ENGINEERING

ANNUAL REPORT

2008-2009



We are glad to share with you news about our program for the academic year 2008-2009. With the specter-turned-reality of budget cuts affecting many institutions of higher learning in the US, the Electrical Engineering Department at UCLA continued to press ahead with confidence and pragmatism. The consolidation of the department activities into three major areas and the addition of 13 outstanding faculty members over the last few years streamlined our operations, strengthened the outreach of our program into exciting new areas, and enabled more efficient planning of course and laboratory offerings.

This report highlights the range of research and educational activities in our department over the last academic year, and lists the recognitions that were received by our faculty members and students for their outstanding scholarly work:

- Computer Science and Electrical Engineering Professor Deborah Estrin was inducted into the **National Academy of Engineering** (NAE) in February 2009 for the pioneering design and application of heterogeneous wireless sensing systems for environmental monitoring.
- Professor Alan N. Willson, Jr. was selected to receive the 2010 **IEEE Leon K. Kirchmayer Graduate Teaching Award** from IEEE for his exemplary teaching and curriculum development and for inspirational guidance of Ph.D. student research in the area of Circuits and Systems.
- Professor Chand Joshi was selected to receive the 2009 **Particle Accelerator Science and Technology Award** from the IEEE Nuclear and Plasma Science Society. The award recognizes individuals who made outstanding contributions to the development of particle accelerator science and technology.
- Professor Yahya Rahmat-Samii received the 2009 **Distinguished Achievement Award** from the IEEE Antennas and Propagation Society for his contributions to the design, optimization and measurement of modem ground and space-borne reflector antennas and antennas for handheld communication devices.
- Professor Kang Wang was awarded the 2009 **University Researcher Award** from the Semiconductor Industry Association (SIA), which is the leading voice for the semiconductor industry in the U.S.
- Assistant Professor Paulo Tabuada received the prestigious 2009 **Donald P. Eckman Award** from the American Automatic Control Council. The award recognizes outstanding achievements by a young researcher under the age of 35 in the field of control theory. It is considered one of the most prestigious awards in the field.
- Assistant Professor Aydogan Ozcan received the 2009 **IEEE LEOS Young Investigator Award** from the IEEE Society for Photonics. The award honors an individual who made outstanding technical contributions to photonics (broadly defined) prior to his or her 35th birthday.
- Assistant Professors Dejan Markovic and Puneet Gupta received 2009 **NSF CAREER Awards** and Assistant Professor Aydogan Ozcan received a 2009 ONR Young Investigator Award.

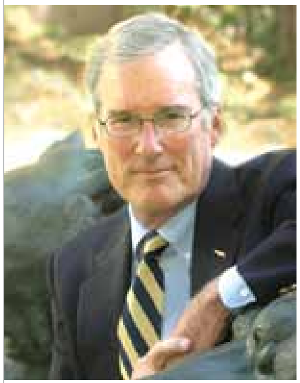
We are also proud of the support that we continue to receive from our industry partners and alumni. We are particularly thankful to Qualcomm, an active member of our Industry Affiliates Program, for funding three new graduate student fellowships in the department. In addition, two endowed graduate fellowships of $500K each were established by two of our alumni: Dr. Fang Lu (MS '88, Ph.D. '92) and Dr. Mukund Padmanabhan (MS '89, Ph.D. '92). Both fellowships will support graduate students studying in the areas of Circuits and Embedded Systems or Signals and Systems.

Several major research projects received support from national funding agencies. In particular, DARPA funded two projects under the HEALICs initiative in the department at a total funding level of approximately $8M. One project (led by Professor Frank Chang) pursues work on self-healing 4Giga-bit/sec reconfigurable CMOS radios-on-a-chip, and the other project (led by Professors Razavi, Markovic, Cabric, Woo, and Sayed) pursues work on self-healing mixed-signal baseband processors for cognitive radios.

We are proud of the accomplishments of our faculty members and their research groups. We are also grateful to our staff and supporters for their continued and valued contributions to our program.

Ali H. Sayed
Department Chairman

DEPARTMENT ADVISORY BOARD



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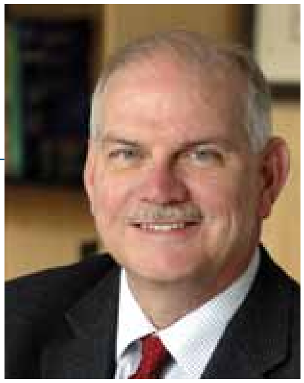
(UC Berkeley)

Professor Emeritus of Electrical Engineering and Computer Science
Executive Vice Chancellor and Provost Emeritus
Former Dean of Engineering
National Academy of Engineering



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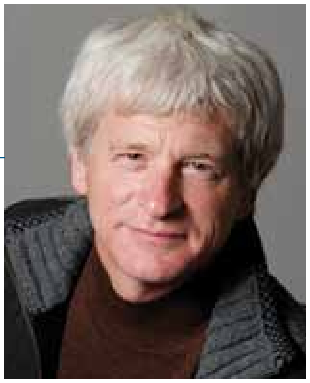

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Donald O. Pederson Professor of Electrical Engineering and Computer Science
Scientific Director of Berkeley Wireless Research Center

PROFESSOR THOMAS KAILATH
(Stanford)

Hitachi Professor Emeritus of Electrical Engineering
National Academy of Engineering
National Academy of Sciences
IEEE Medal of Honor

PROFESSOR ALAN WILLSKY
(MIT)

Professor of Electrical Engineering and Computer Science
Director of MIT LIDS (Laboratory for Information and Decision Systems)

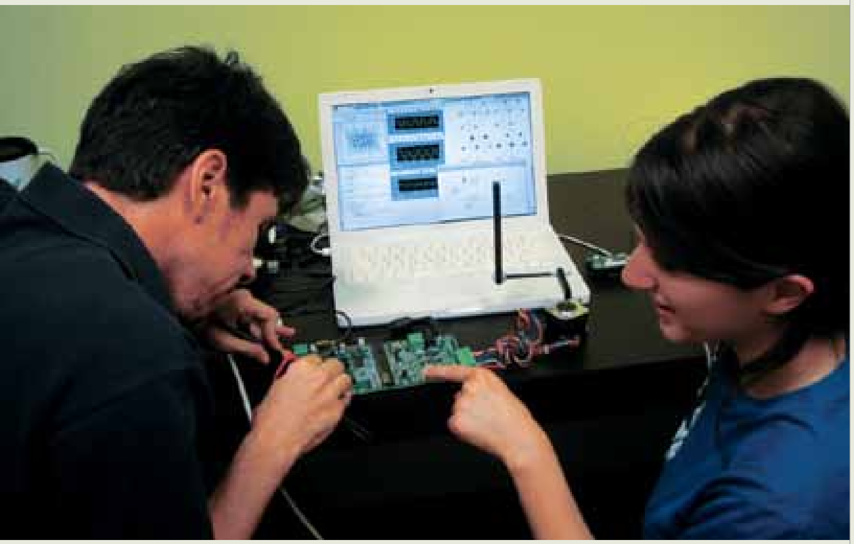
PROFESSOR ASAD ABIDI
(UCLA)

Professor of Electrical Engineering
National Academy of Engineering
Faculty Liaison to the Department Advisory Board

Assistant Professor Paulo Tabuada receives the 2009 Donald P. Eckman Award

Assistant Professor Paulo Tabuada received the prestigious 2009 Donald P. Eckman Award from the American Automatic Control Council for pioneering contributions to the design and implementation of hybrid and embedded control systems. The award recognizes outstanding achievements by a young researcher under the age of 35 in the field of control theory. It is considered one of the most prestigious awards in the field.

Professor Tabuada joined the Electrical Engineering Department in July 2006. At UCLA he established and directs the Cyber-Physical Systems Laboratory where he conducts research at the interface between control theory and computer science.



Students debugging an embedded controller at CyPhyLab

Cyber-physical systems (CPSs) are characterized by a tight integration between computation (the cyber part) and the physical world (the physical part). Cars provide a particularly rich example of a CPS. Modern cars typically rely on more than 80 microprocessors to gather and process information from the physical world (car+environment) in order to improve safety, comfort, performance, and reduce tailpipe emissions. At the core of this CPS are several feedback control loops implemented in software deployed on multiple processors and requiring the exchange of messages through several buses. As drivers, we expect ABS and other dynamic and stability control systems to function correctly all the time. But correct operation of such systems requires a careful analysis and design of the complex interactions between the control software, the exchange of messages between microprocessors, sensors, and actuators, and the dynamics of a car. The importance of CPSs extends far beyond the automotive industry: copier machines use advanced control loops to prevent paper jams caused by manufacturing defects, paper irregularities, and normal wear and tear while printing more than two pages per second; building management systems employ distributed sensors, actuators, and control loops to reduce overall energy usage while regulating temperature, humidity, elevator schedules, appliance schedules, water and electricity distribution, etc; laparoscopic surgery and telesurgery are enabled by numerous embedded control loops designed to eliminate the limitations of human ergonomics while improving the surgeon dexterity and precision.

Several of the previously described examples are safety-critical and small software bugs can have catastrophic consequences. Moreover, such errors are difficult to detect since they arise through unexpected interactions between the software, the implementation platforms, and the continuous dynamics of the physical world. This is what makes CPSs an exciting area of research. One has to go beyond functional properties of software and reason about non-functional properties such as time and robustness. Unfortunately, such properties are not expressible in traditional models of computation such as Touring machines or finite-state automata. This is in sharp contrast with the models used for control, such as differential equations, where time and robustness can be easily expressed and analyzed. The group of Prof. Tabuada has developed several results allowing to relate the differential equation models used for control with the finite-state models used to describe software. Such results serve as a bridge allowing one to exchange analysis and design techniques between control and computer science, thus advancing our understanding of CPSs.

Professor Ozcan working in his lab with Javad Farhani, Sungkyu Seo, Justin Su and Derek Tseng (from left to right) Photo by Phil Channing

Assistant Professor Aydogan Ozcan receives *2009 IEEE LEOS Young Investigator Award*

Assistant Professor Aydogan Ozcan recently received the 2009 IEEE LEOS Young Investigator Award from the IEEE Society for Photonics. The award honors an individual who made outstanding technical contributions to photonics prior to his or her 35th birthday. Professor Ozcan is being recognized for his pioneering contributions to non-destructive nonlinear material characterization techniques, near-field and on-chip imaging and diagnostic systems.

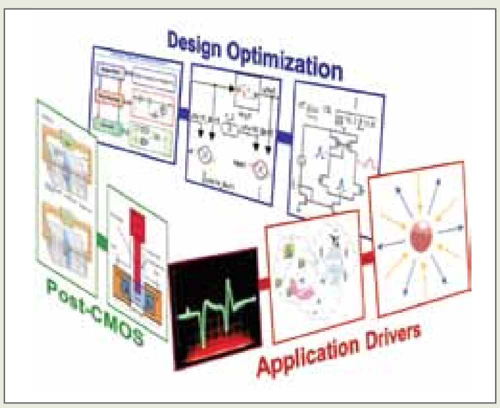
The figure shows a regular cell phone that is converted into a microscopic imager through lenfree holography.

In resource limited settings, such as in the villages of Africa, there is no infrastructure to conduct even simple medical tests such as blood counts. For such tests to be performed in the field, wireless technologies are needed that can capture the micro-scale signatures of various cells at resource poor settings. Cell phones offer a great match for this purpose since: (1) they are currently used nearly everywhere; and (2) they are equipped with advanced technologies that could be tailored towards the needs of such medical tests. In his research group at UCLA (http://innovate.ee.ucla.edu/), Professor Ozcan developed a transformative solution to health global challenges by providing a revolutionary optical imaging platform that can be used to analyze bodily fluids within a regular cell phone. Through wide-spread use of Professor Ozcan's innovative technology, health care services in developing countries can be improved making a real impact in the life quality and life expectancy of millions.

The core technology of his approach relies on an innovative on-chip platform, developed at UCLA, which is termed, "***LUCAS*** *– Lensfree* ***U****ltra-wide field* ***C****ell monitoring* ***A****rray platform*," that is based on *Shadow Imaging*. For most bio-medical imaging applications, directly seeing the structure of the object is of paramount importance. However, for imaging and monitoring of discrete particles such as cells or bacteria, there is a much better way of imaging that relies on detection of their ***shadow signatures***. By making use of this new way of thinking, unlike conventional lens based imaging approaches, LUCAS does not utilize any lenses, microscope-objectives or other bulk optical components, and it can immediately monitor an ultra-large field of view by detecting the holographic shadow of cells or bacteria of interest on a chip. Through advanced signal processing tools that are running at a central computer station, the unique texture of these cell/bacteria holograms will enable the performance of highly specific and accurate medical diagnostics in resource poor settings by utilizing the existing wireless networks.

Assistant Profrossor Dejan Markovic
receives the 2009 NSF Career Award

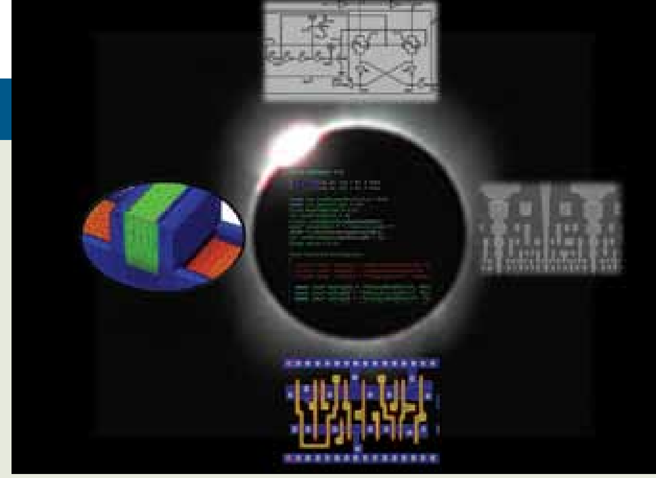
Professor Markovic's career award recognizes his career development plan entitled *Area-and-Power-Minimized Many-Channel Neural-Spike DSP*. Prof. Markovic's research focuses on bringing CMOS to new application domains and on design with post-CMOS devices. His research group is working on the design optimization infrastructure needed to support complex digital circuits and systems. The optimizations include word length optimization of DSP algorithms, compact models and simulation environments for mitigating random process variations in analog and mixed-signal circuits, and high-level DSP architecture optimization for reduced chip power and area. Application drivers for the CMOS technology include designs with a variety of power and performance characteristics: multi-GHz cognitive radio and digital front-end processing, multi-MHz parallel data processing for multi-antenna radios, and down to multi-KHz rate many-channel neural-spike processing. The power requirements for these diverse applications also vary by orders of magnitude, from milliwatts to microwatts. The hierarchical architecture optimization allows for rapid prototyping and integration of very complex digital designs. For example, his group has demonstrated a multi-antenna baseband DSP with support of up to 16x16 antennas that is also flexible to support a variety of antenna configurations, modulation schemes and carriers.



Prof. Markovic's research activities: digital integrated circuit optimization in power-area-performance space, its application to emerging health care and communication algorithms, and the investigation of design principles with post-CMOS devices.

In today's design, one must also cope with unique technology features such as device variations and power leakage. Professor Markovic's variation analysis research has demonstrated designer-friendly compact model that maps random variation of the drain current into design variables: transistor operating voltages, channel width and length. This model has been integrated into Berkeley SPICE tools to obtain voltage variance in mixed-signal circuits in a single iteration as compared to time-inefficient Monte-Carlo methods. This work has immediate application to yield enhancement for analog-to-digital converters. He's now working on ADC designs for low-voltage neural implants and ultra-high performance radio applications with the goal of maximizing yield and power efficiency.

Prof. Markovic's research is also focusing on circuit design techniques with post-CMOS devices to identify designs and technologies that can substitute CMOS in certain applications or open up new applications previously not possible with CMOS. His group is specifically working on design with nano-mechanical relays that show an order or magnitude improvement in energy efficiency compared to CMOS. An interesting finding was that although relay devices are larger than today's CMOS transistors, an adder can be implemented with 1/3 the number of relays as compared to CMOS. Excellent (zero) leakage property of these devices are quite attractive for future ultra-low-power devices. Another type of post-CMOS devices are magneto-resistive tunneling based devices that offer non-volatility and great device density on top of standard CMOS process. Prof. Markovic's students are working on memory design with spin-torque transfer based magnetic-tunnel junctions. This memory structure holds promise for being a universal memory of the future.



NanoCAD Lab focuses on computationally aided optimizations across the integrated circuit design-manufacturing interface.

Assistant Professor Puneet Gupta *receives the 2009 NSF Career Award*

Professor Gupta's career award recognizes his career development plan entitled *Co-optimization of Integrated Circuit Design and Manufacturing*. The plan aims to investigate methods for co-optimization of integrated circuit design and the manufacturing process for improved power, performance, yield, cost and turnaround time. The semiconductor industry is likely to see several radical changes in the fabrication and device technologies in the next decade. Each of these technologies requires enormous research investment before they can see any adoption. Conventional after-the-fact changes to design methodologies and tools to technology lead to wasted effort and under-utilization of technology. The project targets "equivalent scaling" improvements — perhaps as much as one full technology generation, coming from new synergies between various "silos" of the integrated circuit design to manufacturing flow. Professor Gupta's research group focuses on early assessment of circuit design and layout restrictions imposed by technological choices. His work plans on developing an algorithmic method of manufacturing process optimization driven by design analyses to significantly speed up yield ramp and improve product characteristics.

Professor Gupta research group is also optimizing interfaces between traditional isolated parts of the application-architecture-implementation-fabrication flow for nano-electronic systems. Modern nano-systems are complex and, hence, need layers of abstraction to manage design and verification. Therefore, the interfaces have to preserve the abstractions while optimizing the information exchange. Professor Gupta's current work centers specifically on the following two aspects.

- **The Design-Manufacturing Interface**. For design for manufacturing (DFM) and manufacturing for design (MFD) models and methods to be defensible and adoptable, they have to be as simple as possible without losing physical justification. His ongoing research is re-evaluating several assumptions that CAD research has made in recent years to avoid "DFM overkill"
- **The Application-Architecture-Implementation Interface**. So far, hardware designers have largely overlooked the fact that software is easily adaptable: a fact that can help relax hardware implementation and manufacturing constraints. Professor Gupta is developing a rigorous theoretical and practical framework and associated techniques to establish a bidirectional dataflow between the system/application layer and the physical/circuit implementation layer in the presence of manufacturing variability.

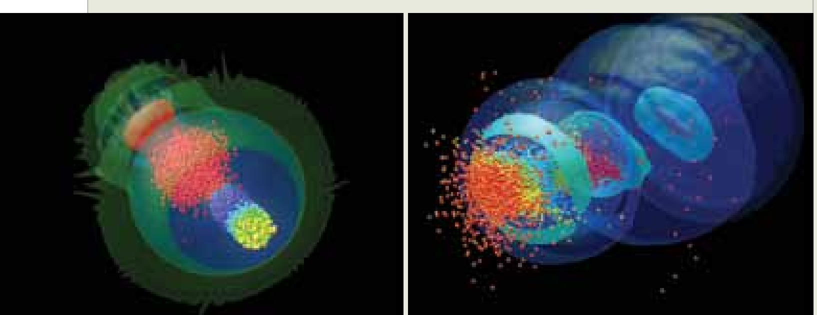
Distinguished Professor Alan N. Willson, Jr. receives the 2010 IEEE Leon K. Kirchmayer Graduate Teaching Award

Distinguished **Professor Alan N. Willson, Jr.** received the 2010 IEEE Leon K. Kirchmayer Graduate Teaching Award for his "*exemplary teaching and curriculum development and for inspirational guidance of Ph.D. student research in the area of circuits and systems.*" The IEEE Graduate Teaching Award is a Technical Field Award whose purpose is to honor teachers of electrical and electronics engineering and the related disciplines, for inspirational teaching of graduate students in the IEEE fields of interest. This is an IEEE-wide award and covers all fields of Electrical Engineering. Professor Willson has been a faculty member in Electrical Engineering at UCLA since 1973. He has had an illustrious career and his research has been recognized with some of the most distinguished prizes and awards in the field. His areas of research include computer-aided circuit analysis and design, the stability of distributed circuits, properties of non-linear networks, theory of active circuits, digital signal processing, and analog circuit fault diagnosis. He received the IEEE Baker Prize twice (1985, 1994); a singular accomplishment since the prize is the most prestigious paper award across all IEEE publications. His other distinctions include the following:

- 2009 Distinguished Lecturer, IEEE Circuits and Systems Society
- 2003 Mac Van Valkenburg Award, IEEE Circuits and Systems Society
- 2000 Technical Achievement Award, IEEE Circuits and Systems Society
- 1994, 1985 IEEE W.R.G. Baker Prize Award
- 1994, 1979 Guilleman-Cauer Prize Award, IEEE Circuits and Systems Society
- 1982 George Westinghouse Award, American Society for Engineering Education

Professor Chand Joshi receives the 2009 IEEE NPSS *Particle Accelerator Science and Technology Award*

One key tool that provided breakthroughs in our comprehension of the physical world is the high-energy particle collider, popularly known as the atom smasher. For decades, particle colliders have used electric fields in microwaves cavities to accelerate charged particles to extremely high energies. However, unless an entirely new paradigm for accelerating particle beams is successfully introduced very soon, the 8.6 kilometer-diameter Large Hadron Collider (LHC) at CERN in Switzerland ,with a price tag close to 10 billion dollars, may be the last such machine to be built based on this decades old technology.



"Extreme" wave in a plasma produced by an ultra-intense electron beam. Image by F.Tsung UCLA

Of the many different alternate techniques that have been explored, the Plasma-Wakefield Accelerator, a concept that originated at UCLA, is one concept that has made spectacular advances in the last decade. In this idea, electrons or positrons gain energy by surfing the electric field of a plasma wave, also known as the wakefield, that is produced by the passage of an intense laser pulse or an electron beam through an ionized gas or a plasma. The wakefield can be thousands of times stronger than fields in conventional microwave cavities, therefore plasma accelerators have the promise of being more compact and less expensive.

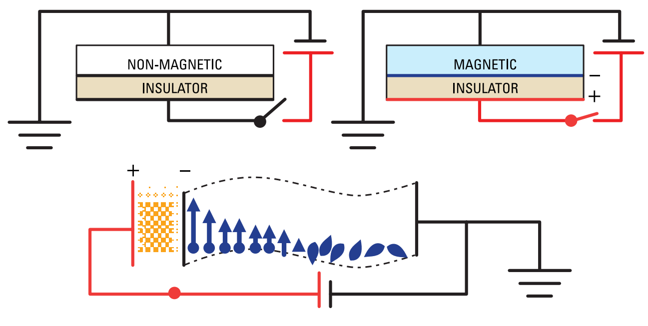
Pioneering work was carried out on proof-of-concept experiments on electron acceleration using plasma waves excited by laser beams soon after **Professor Chan Joshi** arrived at UCLA in 1980. Since then this research field has grown to more than 45 groups worldwide, many tracing their pedigree back to Professor Joshi's group at UCLA.

Recent results by Professors Joshi and Mori of UCLA in collaboration with scientists from University of Southern California, and Stanford have demonstrated what most scientists in the field thought was in the realm of science fiction. They doubled the energy of 42 billion volt electrons, from the 3 km long SLAC accelerator, using a PWFA that was only one meter in length producing energy gains of interest to high-energy physicists.

There is much to do before one can declare that we have a viable alternate technology for building future colliders. The challenge of building smaller, cheaper but more powerful atom smashers are so great that the National Academy of Engineering has declared the development of this critical tool of discovery one of fourteen engineering grand challenges. The faculty, scientists and students in the Electrical Engineering Department are poised to face this challenge!

Professor Kang Wang
Receives the 2009 University Researcher Award

Each year, the Semiconductor Industry Association (SIA) recognizes university researchers who made significant contributions to solving the obstacles that must be overcome to continue the technology roadmap. **Professor Kang Wang** received the award to recognize his relevant work addressing the significant challenges the semiconductor industry is facing as they move beyond the horizons of the International Technology Roadmap for Semiconductors.



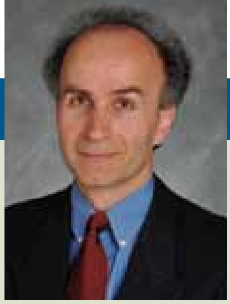
The two upper figures illustrate that the application of voltage triggers the magnetization across the metallic ferromagnetic film. Lower figure is an illustration of the "inverse domino" alignment of spins due to the large spin-correlation length in the critical system near its ferromagnetic-paramagnetic transition.

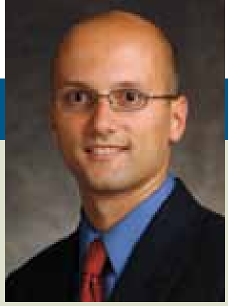
Dr. Wang is a professor in the Electrical Engineering Department at UCLA since 1979, and served as chair of the department from 1993 to 1996. He is currently involved in research projects in the general area of spintronics. In particular, his group is investigating devices based on spin waves for low-power/high-performance logic and information processing. He is active in the area of spin-torque-transfer (STT) devices, aiming at the development of scalable non-volatile STT-based random access memory (RAM). Additionally, the group is working on MBE-growth of dilute magnetic semiconductors, as well as graphene-based electronics and novel molecular electronic devices. His work with Intel on spin field effect transistors shed new light on the power dissipation performance of nanodevices. Another area of his research is on the electric field controlled phase transitions in magnetic nanostructures. Professor Wang is focusing his efforts on the demonstration of novel spin-based logic circuits with capabilities far beyond the scaled CMOS.

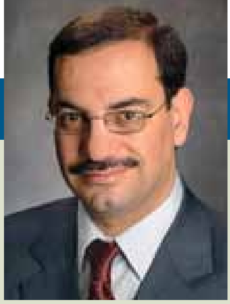
Professor Wang is actively involved in advanced material development, characterizations, device fabrications and device physics. His research covers traditional semiconductors based on GaAs, GaN, SiGe, ZnO and the emerging microwave and graphene devices. He has extensive expertise in the following areas: 1) self-assembled growth of quantum structures and cooperative assembly of quantum dot arrays using Molecular Beam Epitaxy; 2) GaAs and GaN based electronic and optoelectronic devices; 3) Mn-doped III-V and IV Spintronics materials and devices; 4) Electron spin and coherence properties of SiGe and InAs quantum structures for implementation of spin-based quantum information; 5) microwave devices; and 6) graphene devices. Currently, he is dedicating his efforts towards achieving prototype spin-FET devices based on the Mn doped GaN and MnGe material systems. He has successfully demonstrated a field controlled ferromagnetism up to 100 K which presents a major step towards the next-generation spin- FETs. In addition, the researchers in his group have revealed new physics in analyzing the noise of graphene devices, which provides fundamental understanding of graphene physics.

Professor Deborah Estrin is Elected *to the National Academy of Engineering*

Deborah Estrin, a Professor of Computer Science and Electrical Engineering, and the founding director of the Center for Embedded Networked Sensing (CENS) at UCLA, is the first female faculty member from UCLA to be elected to the academy. She was one of four women elected this year, making her one of only 104 female academy members. The National Academy of Engineering includes 2,246 U.S. members and 197 foreign associates. Estrin, who holds UCLA's Jon Postel Chair in Computer Networks, made pioneering contributions in the design and application of wireless sensing systems for environmental monitoring and is a national leader in the advancement of embedded sensing research. Prior to her work in embedded sensing, she co-developed multicast routing protocols that became Internet standards and played an integral role in developing the ns-2 network simulator, an important tool in the network research community. 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. "*As I reflect upon the last decade of developing and exploring embedded sensing systems for environmental monitoring, I feel particularly grateful to my students and multidisciplinary collaborators for making it such a rewarding and stimulating process*," Estrin said.


Behzad Razavi


Dejan Markovic


Ali H. Sayed


Danijela Cabric


Jason Woo

DARPA HEALICS: *A Self-Healing Mixed-Signal Baseband Processor for Cognitive Radios*

The congestion in the frequency spectrum continues to rise as more users access wireless networks. Cognitive radios (CRs) offer an approach to alleviating this issue: they continually sense the spectrum and detect and utilize unoccupied channels. While present efforts in CR design have focused on the TV bands below 1 GHz, it is expected that CRs will eventually operate from tens of megahertz to about 10 GHz .

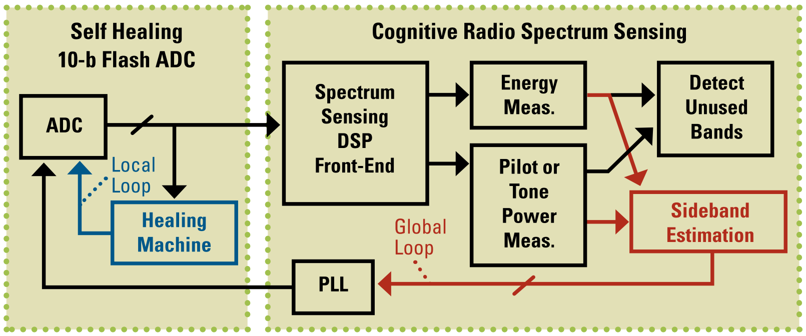
The DAPRA HEALICS initiative has provided a framework for the development of cognitive radios with the aid of "self-healing" circuits. Such circuits incorporate innovative techniques to overcome device and system imperfections, targeting an order of magnitude improvement in the performance.

A challenging task in cognitive radios is spectrum sensing, i.e., determining which channels are not occupied. In the presence of "shadowing," the system must identify signals that are as much as 20 dB below noise. Channel-by-channel sensing greatly eases the design of the baseband analog-to-digital converter (ADC) but it requires an inordinate amount of time for sensing a large number of channels.

A more practical method is to take a spectral snapshot of a block of channels. Unfortunately, in the presence of numerous occupied RF channels, the ADC must achieve a wide dynamic range and a high bandwidth. In fact, the probability of finding an available channel is directly proportional to both the resolution and the sampling speed of the ADC: downconversion of a broader block of channels raises the probability but demands a proportionally higher ADC resolution because the number of high-power channels is also potentially larger.

It is therefore desirable to maximize the dynamic range and speed of the ADC while maintaining low power consumption.

Architecture of Cognitive Radio Baseband Processor



Shown in the figure, the mixed-signal cognitive radio baseband processor envisioned in this program consists of a high-speed, low-power analog-to-digital converter (ADC), a phase-locked loop (PLL), and a spectrum sensing processor (SSP). The ADC and PLL employ self-healing techniques to achieve unprecedented performance, and the SSP implements new algorithms to enable wideband sensing and orchestrate the self-healing of the ADC and the PLL.

This project is led by Professor Behzad Razavi (PI) and by the following co-PI faculty members: Professors Danijela Cabric, Dejan Markovic, Ali H. Sayed, and Jason Woo.

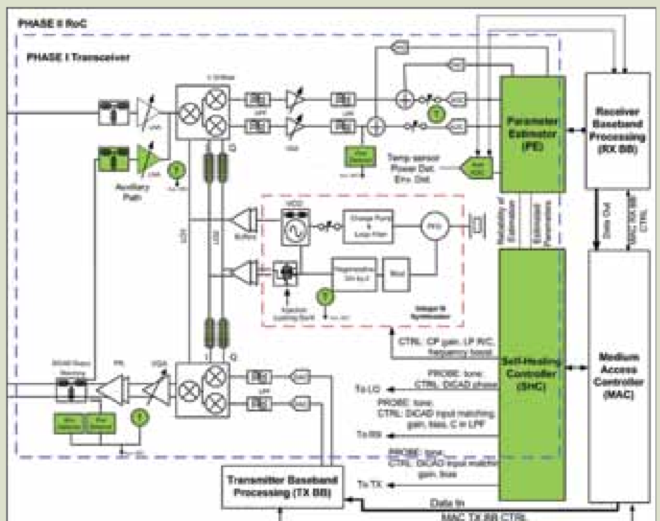
Professor Chang with student researchers Tim LaRocca (white t-shirt) and Daquan Huang Photo By Don Liebig

DARPA HEALICS: *Self-Healing 4Gbps Reconfigurable CMOS Radio-on-a-Chip*

In collaboration with CreoNex Systems, Inc., the High-Speed Electronics Laboratory, under the direction of Professor Mau-Chung Frank Chang, is exploring effective self-healing strategies, algorithms and circuit implementations to boost the performance yield of proposed *Reconfigurable Radio-on-a-Chip (RoC)* for broadband (57-64GHz) communication system applications.

The research focuses on the development of scalable circuit level techniques to maximize the number of fully operational reconfigurable CMOS Radio-on-a-Chip (*RoC*) with over-the-air data transmission rates of 4 Gbps from an individual wafer run that meet all performance metrics in the presence of extreme process variations and environmental conditions. Although the specific Reconfigurable RoC design is aimed for applications at 60GHz ISM band, its design methodology and circuit techniques can be equally effective in implementing most broadband or multi-band microwave and mm-Wave radios from 10-100GHz for both commercial and military communication systems.

Despite the present choice of implementing the integrated transceiver (i.e. the mixed-signal core) in 90nm CMOS, it is Professor Chang's goal to ensure that the developed self-healing methods and control algorithms are generic and scalable to future CMOS tech nodes. The project will also produce self-healing IP core libraries (including design algorithms, schematics, circuit net-list and related software control codes for the complete self-healing *RoC*).



Schematic of 60GHz self-healing Radio-on-a-Chip

A self-healing mixed-signal core (an integrated 60GHz reconfigurable transceiver) will be designed and demonstrated. The circuit will be further expanded to demonstrate a completer *Radio-on-a-Chip*.

Researchers have developed a novel, continuously running camera that captures images roughly a thousand times faster than any existing conventional camera.

World's fastest camera relies on an entirely new type of imaging

Ultrafast, light-sensitive video cameras are needed for observing high-speed events such as shockwaves, communication between living cells, neural activity, laser surgery and elements of blood analysis. To catch such elusive moments, a camera must be able to capture millions or billions of images continuously with a very high frame rate. Conventional cameras are simply not up to the task.

Professor B. Jalali's group developed a novel, continuously running camera that captures images roughly a thousand times faster than any existing conventional camera.

In a paper in the April 30 issue of Nature (currently available online), Electrical Engineering researchers Keisuke Goda, Kevin Tsia and Professor Jalali describe an entirely new approach to imaging that does not require a traditional CCD (charge-coupled device) or CMOS (complementary metal-oxide semiconductor) video camera. Building on more than a decade of research on photonic time stretch, a technique for capturing elusive events, the team has demonstrated a camera that captures images at some 6 million frames per second.

One of the applications he envisions for the camera is flow cytometry, a technique used for blood analysis. Traditional blood analyzers can count cells and extract information about their size, but they cannot take pictures of every cell because no camera is fast and sensitive enough for the job. At the same time, images of cells are needed to distinguish diseased cells from healthy ones. Today, pictures are taken manually under a microscope from a very small sample of blood.

But what if you needed to detect the presence of very rare cells that, although few in number, signify the early stages of a disease? Circulating tumor cells are a perfect example. Typically, there are only a handful of them among a billion healthy cells; yet these cells are precursors to metastasis, the spread of cancer that causes about 90 percent of cancer mortalities.

"The chance that one of these cells will happen to be on the small sample of blood viewed under a microscope is negligible," Jalali said. "To find these rogue cells — needles in the haystack — you need to analyze billions of cells, the entire haystack. Ultra-high-speed imaging of cells in flow is a potential solution for detection of rare abnormal cells."

The new imager operates by capturing each picture with an ultrashort laser pulse — a flash of light only a billionth of a second long. It then converts each pulse to a serial data stream that resembles the data in a fiber optic network rather than the signal coming out of a camera. Using a technique known as amplified dispersive Fourier transform, these laser pulses, each containing an entire picture, are amplified and simultaneously stretched in time to the point that they are slow enough to be captured with an electronic digitizer.

The fundamental problem in performing high-speed imaging, Jalali says, is that the camera becomes less and less sensitive at higher and higher speeds. It is simple to see why: At high frame rates, there is less time to collect photons in each frame before the signal becomes weaker and more prone to noise. The new imager overcomes this because it is the first to feature optical image amplification.

"Our serial time-encoded amplified microscopy (STEAM) technology enables continuous real-time imaging at a frame rate of more than 6 MHz, a shutter speed of less than 450 ps and an optical image gain of more than 300 — the world's fastest continuously running camera, useful for studying rapid phenomena in physics, chemistry and biology," said research co-author Goda, a postdoctoral researcher in the group.

The study was funded by the Defense Advanced Research Project Agency (DARPA), the U.S. Department of Defense's central research and development organization.

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 focuses of his research has been the development of high-speed semiconductor devices and 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.

EMERITUS ROBERT S. ELLIOTT

National Academy of Engineering

Professor Emeritus Robert S. Elliott had a long and illustrious career at UCLA. He served as the first Electrical Engineering Department Chair in the (then) School of Engineering and Applied Science and was the first person to hold the Hughes Distinguished Chair in Electromagnetics at UCLA. He became a Fellow of the IEEE in 1961, and was the recipient of the APS Distinguished Achievement Award in 1988. Also in 1988, and even more importantly, Dr. Elliott was honored by the National Academy of Engineering "for basic contributions to the electromagnetic theory and design of array antennas, and for outstanding leadership in engineering education". Additionally, Professor Elliott also was the recipient of several Best Teacher Awards, and two IEEE Best Paper Awards during his career at UCLA. In 2000 he received an IEEE Third Millennium Medal. Dr. Elliott is also the author of two seminal electrical engineering textbooks, Antenna Theory and Design and Electromagnetics.

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.

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 if Illinois ECE Department, Urbana-Champaign.

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 (DSP) and communications systems engineering. He is widely recognized as one of the world's leading experts in the field of broadband communications circuits. He received his BS, 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 in DSP and broadband communications, and is also well known as the co-founder of Broadcom Corporation in 1991.

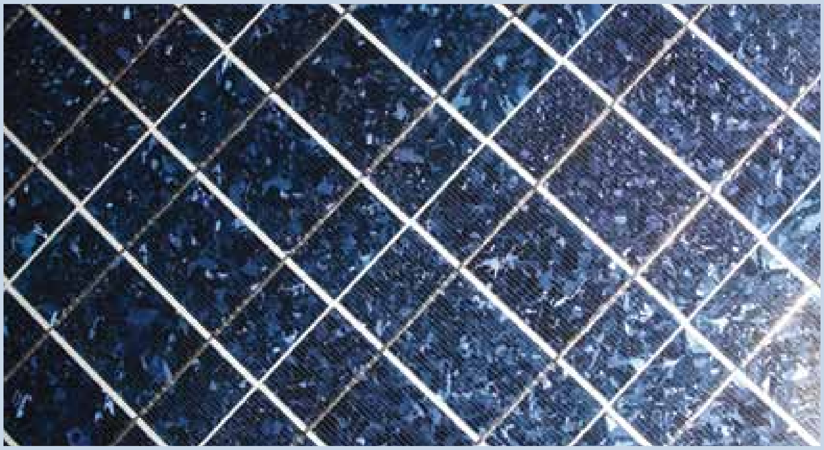
JASON SPEYER

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 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 Engienering Professors Deborah Estrin, Jack W. Judy, William J. Kaiser, Gregory J. Pottie, Mani B. Srivastava, John D. Villasenor, and Kung Yao are active members of the Center.



Solar panel shot in CENS Lab Photo By Phil Channing

California NanoSystems Institute (CNSI)

The California NanoSystems Institute is a research center that is run jointly by UCLA and UC Santa Barbara. CNSI was established in 2000 with $100 million from the State of California and an additional $250 million in federal research grants and industry funding. Its mission is to encourage university collaboration with industry and enable the rapid commercialization of discoveries in nanosystems. In particular, CNSI is working to:

- establish a world-renowned center for nanosystems research and development
- develop commercial applications of CNSI's technology
- educate the next generation of scholars in nanosystems R&D
- promote regional development through commercial use of nanotechnology
- generate public appreciation and understanding of nanotechnology

CNSI's new building on the campus of UCLA is home to eight core facilities which will serve both academic and industry collaborations.

CNSI members who are on the faculty at UCLA are Professors Kang Wang, Jack Judy, Diana Huffaker, Aydogan Ozcan, Vwani Roychowdhury, Bahram Jalali, and Jason Woo of the Electrical Engineering Department are members of CNSI. Professor Kang Wang is the Associate Director.

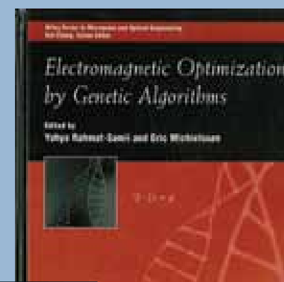
Center on Functional Engineered Nano Architectonics (FENA)

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, will receive $13.5 million over the first three years, and as much as $70 million over 10 years. 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)

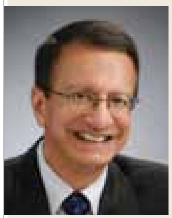
The Western Institute of Nanoelectronics is a multi-disciplinary center that is among the world's largest spintronics efforts. WIN was established in 2006 and is headquartered at UCLA, led by Electrical Engineering Professor Kang Wang. The institute involves collaborations among 8 national universities with 32 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 Western Institute of Nanoelectronics was established with funding totaling over $20M 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, Freescale and MICRON. In 2008, the National Institute of Standards and Technology (NIST), a federal technology agency, also joined the sponsoring industry consortia.

Numerous textbooks on graduate and undergraduate instruction are authored by our electrical engineering faculty. This is a sample of the publications.

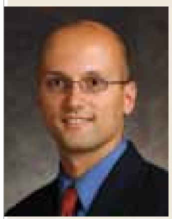


FACULTY AWARDS

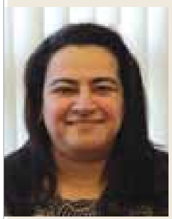
PROFESSOR DEBORAH ESTRIN
Elected to National Academy of Engineering



PROFESSOR CHAND JOSHI
2009 Particle Accelerator Science and Technology Award



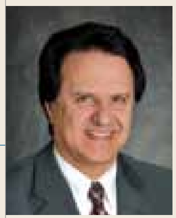
ASSISTANT PROFESSOR DEJAN MARKOVIC
2009 NSF CAREER Award



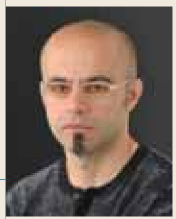
PROFESSOR ABEER ALWAN
International Speech Communication Association (ISCA) Distinguished Lecturer

PROFESSOR PUNEET GUPTA
2009 NSF CAREER Award

PROFESSOR AYDOGAN OZCAN
2009 Wireless Innovation Competition Award
2009 IEEE LEOS Young Investigator Award

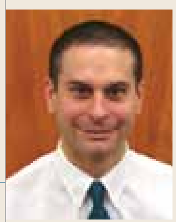


PROFESSOR YAHYA RAHMAT-SAMII
2009 Distinguished Achievement Award, IEEE Antennas and Propagation Society



ASSISTANT PROFESSOR PAULO TABUADA
2009 Donald Eckman Award

PROFESSOR KANG WANG
2009 University Researcher Award



PROFESSOR GREG POTTIE
2009 Fulbright Scholar

NEW FACULTY

LARA DOLECEK *Assistant Professor*

Biography Dr. Dolecek received her Ph.D. in 2007 in Electrical Engineering from UC Berkeley and has been a post-doctoral scholar at MIT since then.

She also received an M.A. in Statistics from Berkeley. She was awarded the 2007 David J. Sakrison Memorial Prize for the most outstanding doctoral research from EECS at UC Berkeley.

Research Interests Dolecek's research interests are broad and span 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*

Biography Suhas Diggavi received his Ph.D. in Electrical Engineering from Stanford University. He then joined AT&T Shannon Laboratory, where he was a principal member of technical staff at the Information Sciences Center. He then joined the faculty of Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland, in the School of Computer and Communication Sciences.

He is a recipient of the 2006 IEEE Donald Fink Prize Paper Award, 2005 IEEE VTC best paper award, and the Okawa Foundation Award. He has been an Associate editor for IEEE Communication Letters, and is currently an editor for ACM/IEEE Transactions on Networking and IEEE Transactions on Information Theory. He has 8 issued patents.

Research Interests Suhas Diggavi's research interests are in 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.

Outstanding Chapter Award
HKN Student Organization (Professor Alan Willson, advisor) receives Outstanding Chapter Award.

The 2009 Outstanding Ph.D. Student Award in Electrical Engineering
Ph.D. student Zhi Quan (A. H. Sayed, advisor) was awarded the 2009 Outstanding Ph.D. Student Award in Electrical Engineering. His Ph.D. thesis is entitled: "*Cooperative Spectrum Sensing for Cognitive Radios*".

The 2009 Outstanding Ph.D. Student Award in Electrical Engineering
M.S. student Phillip M. Izdebski (Y. Rahmat-Samii, advisor) was awarded the 2009 Outstanding M.S. Student Award in Electrical Engineering.

The 2009 Outstanding Ph.D. Student Award in Electrical Engineering
Undergraduate student Jeffrey K. Akamine was awarded the 2009 Outstanding B.S. Student Award in Electrical Engineering.

2009 Harry M. Showman Prize from HSSEAS
Graduate student Kevin Kin-Man Tsia (Professor Bahram Jalali, advisor), was awarded the 2009 Harry M. Showman Prize from HSSEAS.

Christina Huang Memorial Prize
Undergraduate student Jonathan Chew was awarded the 2009 Christina Huang Memorial Prize.

2009 Chancellor's Award for Postdoctoral Research Recipient
Dr. Sungkyu Seo, a postdorctoral scholar in Professor Aydogan Ozcan's research group, has been selected to receive the 2009 Chancellor's Award for Postdoctoral Research.

1. EE Departments receives $225,000 gift from Qualcomm for graduate student fellowships (UCLA EE Professor Kaiser (Left), Dean Vijay K. Dhir (Center), Qualcomm Fernando Ramirez (Right)
2. Vice Chair of Graduate Affairs, Professor Mani Srivastava, with the 2009 Christina Huang Memorial Prize recipient Jonathan Chew
3. Dean Vijay K. Dhir awards Harish Rajagopalan (EE Ph.D. student) 1st place for his research poster at the 2009 UCLA Henry Samueli School of Engineering and Applied Science Technology Forum
4. Oustanding M.S. Student Award recipient Phillip Izdebski with his thesis advisor, Professor Yahya Rahmat-Samii
5. From left to right, top row: Chairman Ali H. Sayed, Outstanding Ph.D. Student Zhi Quan, Professor Yahya Rahmat-Samii, Oustanding M.S. Student Phillip Izdebski, Vice Chair of Graduate Affairs Professor Mani Srivastava, Bottom Row: Outstanding B.S. Student Jeffrey Akamine, Sr. Lecturuer Dr. Mike Briggs, and Christina Huang Memorial Prize recipient Jonathan Chew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5

DEPARTMENT OVERVIEW

FACULTY AND STAFF

Ladder Faculty	44.5 FTEs
Courtesy Appointments	9
Emeriti Faculty	11
Adjunct	11
Lecturers	14
Staff	37

RECOGNITIONS

Society Fellows	32
NAE Members	7
NAS Members	2
National Medal of Science	1

RESEARCH FACILITIES

Laboratories and Research Groups: 37

Space: 104, 119 square feet

DEPARTMENT CONTRIBUTES TO 8 RESEARCH CENTERS

California NanoSystems Institute (CNSI)

Center for Embedded Networking Sensing (CENS)

Center for High Frequency electronics (CHFE)

Center for Systems, Dynamics and Controls (SyDyC)

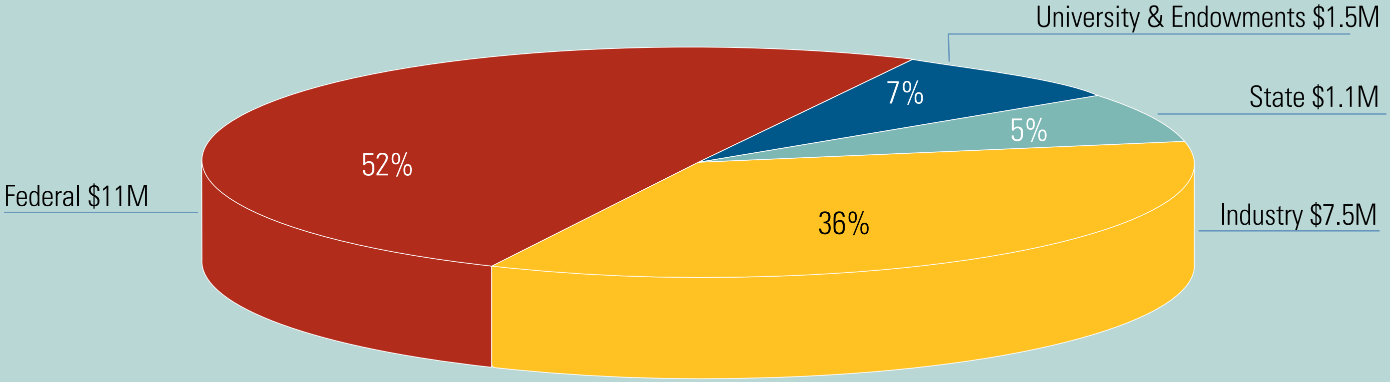
Functional Engineered Nano Architectonics Focus Center (FENA)

Institute for Cell Mimetic Space Exploration (CMISE)

Nanoelectronics Research Center (NRC)

Western Institute of Nanotechnology (WIN)

RESEARCH FUNDING 2008-2009 ($21.1M)



UNDERGRADUATE STUDENTS

Students Enrolled	660
Applicants	1029
New Students Enrolled	196
Average Freshman GPA	3.77

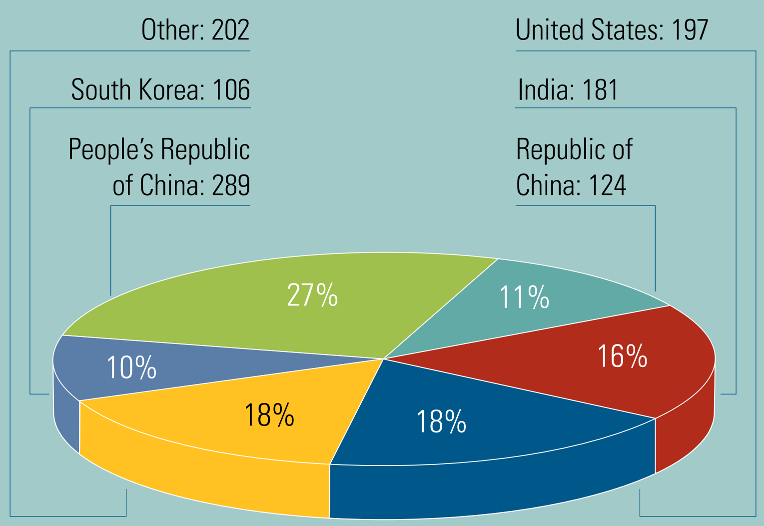
GRADUATE STUDENTS

Students Enrolled	377
Applicants	1099
New Students Enrolled	146
Average Incoming GPA	3.68

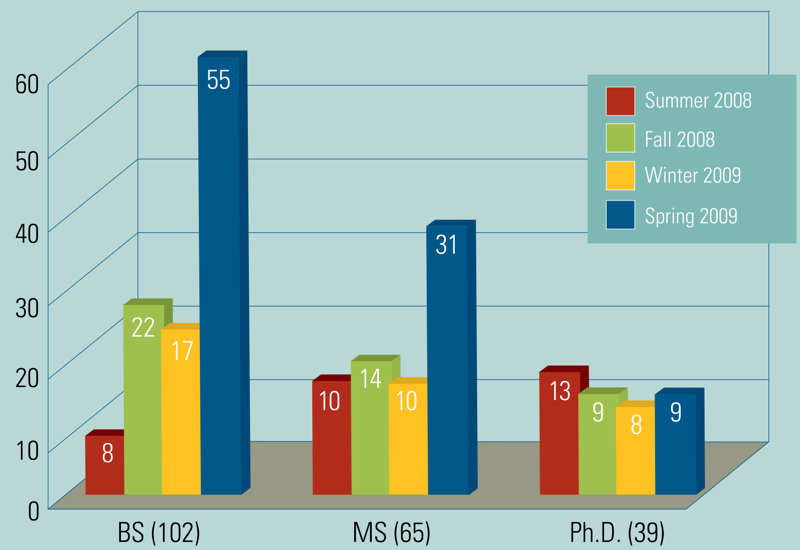
FELLOWSHIPS RECEIVED BY ELECTRICAL ENGINEERING GRADUATE STUDENTS

Full Fellowships	$	320,579.00
Dean's GSR Support	$	175,141.00
Non-Resident Tuition Support for Teaching Assistants	$	171,430.00
Partial Departmental Fellowships	$	160,095.00
Henry Samueli Partial Fellowships	$	113,556.00
Faculty Unrestricted Fellowships	$	112,828.00
Chancellor's Prize	$	103,882.00
Dissertation Year Fellowships	$	82,415.00
Ph.D. Preliminary Exam Top Score Fellowships	$	38,573.00
Cota Robles Research Mentorship	$	28,482.00
Dean's Fellowship	$	25,000.00
Graduate Opportunity Fellowship for Entering Student	$	22,170.00
Rockwell Fellowship	$	14,000.00
Control Funds	$	13,900.00
Borgstrom Fellowship	$	10,000.00
Paulson Fund	$	3,500.00
UCLA Affiliates	$	3,000.00
Malcolm R. Stacey Fellowship	$	1,400.00
Conference Travel Funds	$	1,200.00
TOTAL	**$**	**1,401,151.00**

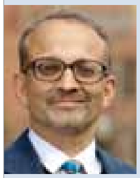
GRADUATE FALL APPLICANTS FOR FALL 2009



EE DEGREES CONFERRED 2008-2009



FACULTY IN CIRCUITS AND EMBEDDED SYSTEMS

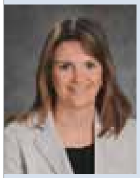


ASAD A. ABIDI, *Professor*

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 networks; VLSI architectures of signal processing and digital communication algorithms; Performance analysis and experiments on embedded system platforms.

M.C. FRANK CHANG, *Professor*

Ph.D., National Chiao-Tung University, 1979

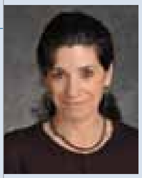
CMOS RF design, high speed analog integrated circuit design, data conversion, and other techniques of analog signal processing.

- 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 strUniversity of Californiature design for generating abstracted process and variation models. Techniques for leakage power modeling and reduction.

LEI HE, *Associate Professor*

Ph.D., University of California, Los Angeles, 1999

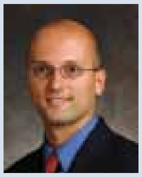
Computer-aided design of VLSI circuits and systems, interconnect modeling and design, power-effi cient computer architectures and systems, and numerical and combinatorial optimization.

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*

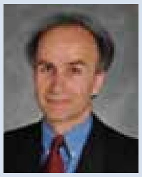
Ph.D., University of California, Berkeley, 2006

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 verifi cation of mixed-signal blocks.

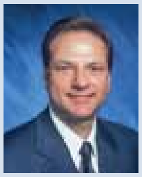


BEHZAD RAZAVI, *Professor*

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

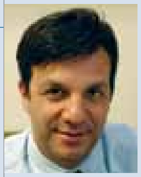


HENRY SAMUELI, *Professor*

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

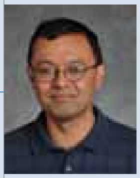


MAJID SARRAFZADEH, *Professor*

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.

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

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.

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.

FACULTY IN PHYSICAL AND WAVE ELECTRONICS

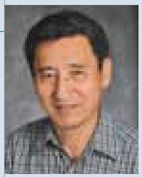
ROBERT CANDLER, *Assistant Professor*
Ph.D., Stanford University, 2006
MEMS and NEMS devices, micro/nanoscale technology development, and the interface of physical microsystems with biology.

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.

HAROLD FETTERMAN, *Professor*
Ph.D., Cornell University, 1968
Optical millimeter wave interactions, femtosecond evaluation of high-frequency devices and circuits, solid state millimeter wave structures and systems, biomedical applications of lasers.
- Fellow, IEEE, 1990
- Fellow, Optical Society of America, 1980

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, semiconductor 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., University of Technology, Darmsstadt, 2002

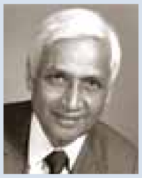
Laser-plasma interactions, high-energy density physics, and inertial confinement fusion.

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

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, *Assistant 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 subwavelength 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, *Professor, Area Director and Vice Chair*

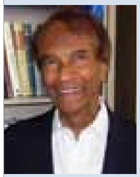
Ph.D., Stanford University, 1987

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

- Fellow, IEEE, 2005

FACULTY IN 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



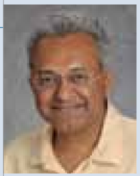
A.V. BALAKRISHNAN, *Professor*
Ph.D., University of Southern California, 1954
Laser beam distortion in atmospheric turbulence, control design for smart structures, and flight systems applications of adaptive control, nonlinear aeroelasticity, and wind power.
- Life Fellow, IEEE, 1996

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, 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

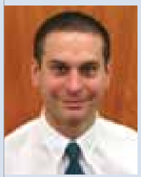


RAJEEV JAIN, *Professor*
Ph.D., Katholieke Universiteit, Leuven, Belgium, 1985
Embedded hardware/software design for signal processing systems-on-a-chip; CAD tools for design of high-performance signal processing architectures and development of ASICs for spread-spectrum modems and image compression.
- Fellow, IEEE, 1999

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

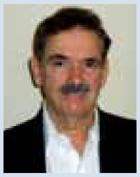
JIN HYUNG LEE, *Assistant Professor*
Ph.D., Stanford University, 2004
Neural information processing and plasticity; Advanced imaging techniques for biomedical applications, neurosciences and neural-engineering; Magnetic Resonance Imaging (MRI); Development of novel image contrast strategies; Alternative image acquisition, reconstruction, and processing techniques.

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

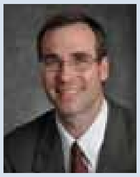


GREGORY J. POTTIE, *Professor*
Ph.D., McMaster University, 1988
Communication systems and theory, with applications to personal communications, channel coding, and wireless sensor networks.
- Fulbright Scholor, 2009
- Fellow, IEEE, 2005

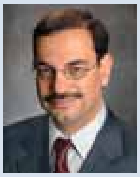
VWANI ROYCHOWDHURY, *Professor*
Ph.D., Stanford University, 1989
Models of computation: parallel systems, quantum information processing, nanoscale and molecular electronics, statistical algorithms for large-scale information processing, combinatorics and complexity and information theory, bioinformatics, cryptography.



IZHAK RUBIN, *Professor*
Ph.D., Princeton University, 1970
Telecommunications and computer communications systems/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



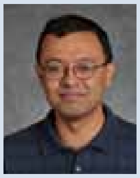
RICHARD D. WESEL, *Professor and Associate Dean*
Ph.D., Stanford University, 1996
Communication theory with a particular interest in coded modulation including trellis codes and turbo codes for applications including mobile wireless communication systems, multiple antenna systems, and satellite communication systems.



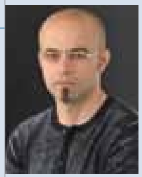
ALI H. SAYED, *Professor and Chairman*
Ph.D., Stanford University, 1992
Adaptive and statistical signal processing, distributed processing, filtering and estimation, signal processing for communications, adaptive and wireless networks, algorithms for large-scale structured computations.
- Fellow, IEEE, 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



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.



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, *Associate 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
Communications, signal and image processing, joint source and channel coding, lattice vector quantization, wavelet filter design, wireless multimedia communications, and low complexity image and video coding architectures and algorithms.

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. 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

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ADMINISTRATION

Ali H. Sayed, *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

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

ABET COMMITTEE

Abeer A. Alwan, *Professor and Area Director*
Ali H. Sayed, *Professor and Department Chair*
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 for affiliate members. In turn, a company's participation in IAP provides essential program enhancement and aid to students with a portion of the funds used for laboratory, instructional and other equipment needs. There are two levels of membership in the program: as an associate member or as a full member. More details are available at the IAP website: http://www.ee.ucla.edu/Industry-home.htm

OUR THANKS TO AFFILIATE MEMBERS FOR THEIR SUPPORT

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Christina Schultise *Administrative Specialist, Assistant to the Chair*
Ali H. Sayed *Professor & Chair*

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Christina Schultise *Administrative Specialist, Assistant to the Chair*

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Jackie Trang *Department Administrator*
Mandy Smith Graduate *Admissions Coordinator*
Deeona Columbia *Director of Graduate Student Affairs*
Matthew Chin *Communications Manager*
Wileen Wong Kromhout *Director of Media Relations and Marketing*
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University of California
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UCLA Engineering
HENRY SAMUELI SCHOOL OF
ENGINEERING AND APPLIED SCIENCE
Birthplace of the Internet