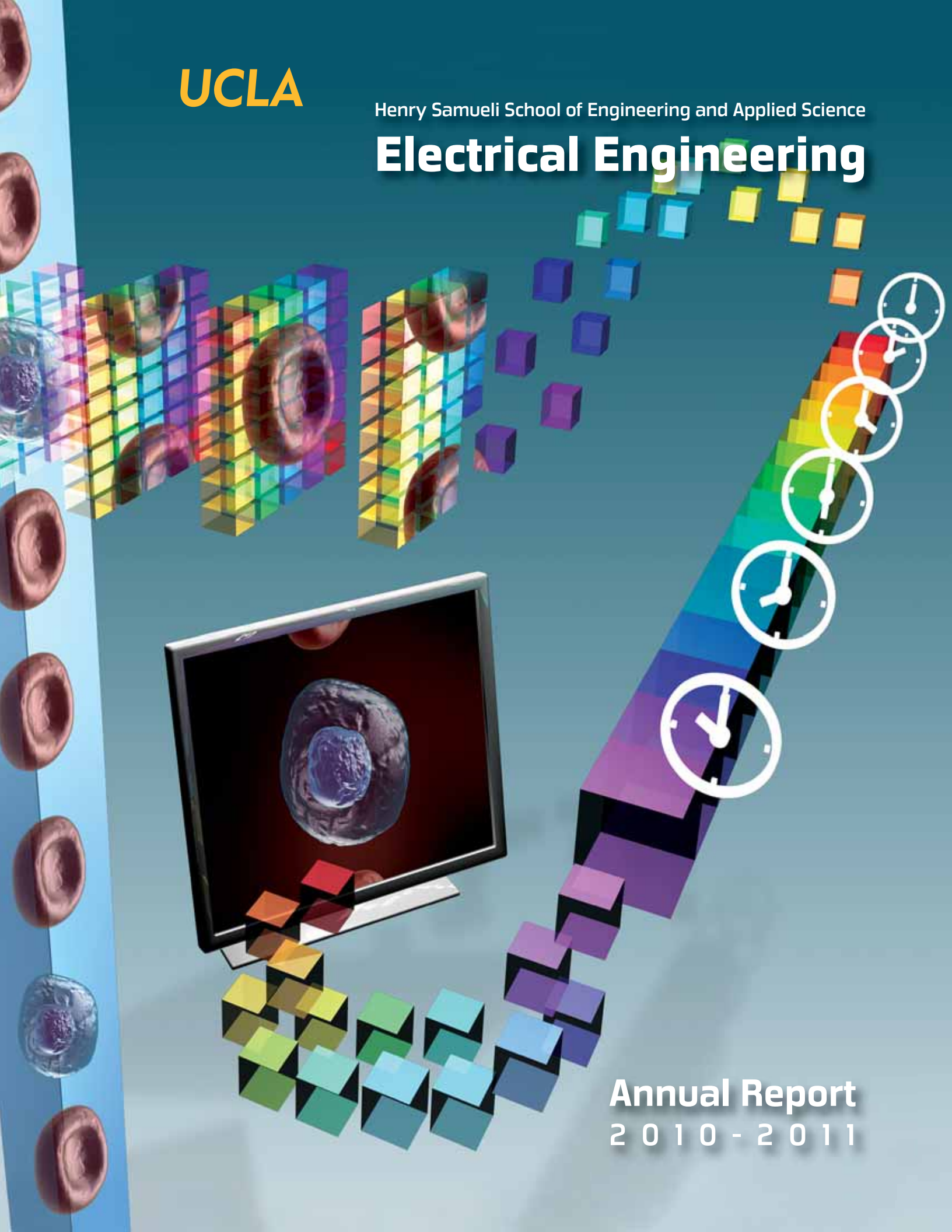
UCLA

Henry Samueli School of Engineering and Applied Science

Electrical Engineering



Annual Report
2010-2011

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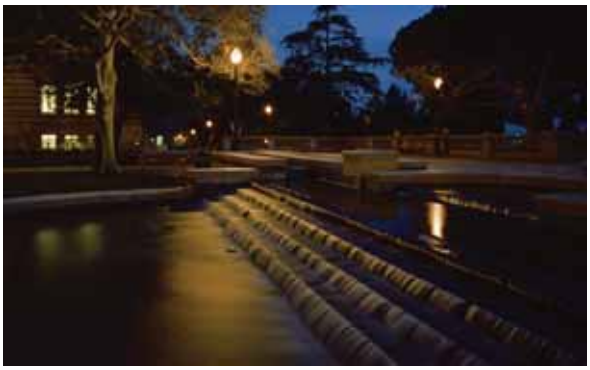


NANO/GREEN/BIO-PHOTONIC TECHNOLOGIES, ADVANCED CIRCUIT/SYSTEM/NETWORK DESIGN METHODOLOGIES STATE-OF-THE-ART RESULTS

Distinguished Professor and Chairman
M.C. Frank Chang

I am pleased to report the activities of UCLA Electrical Engineering for academic year 2010-2011. Our faculty have made strides in developing technology to improve the world we live in and the lives and health of humanity, including:

■ New tools for health and medicine: Professor Bahram Jalali's world's fastest camera (STEAM — Serial Time Encoded Amplified Microscopy) captures the motion of cells, allowing blood samples to be screened quickly and with accuracy. Professr Chi On Chui is developing active sensing devices with gain (such as a nanowire-based FET sensor) for the detection and diagnosis of diseases. The UCLA Wireless Health Initiative, led by Professor William Kaiser, seeks to improve the health and well-being particularly of those in at-risk populations.

■ Innovative technologies to meet increasing demands of the green electronics: Profs. Lara Dolecek, Puneet Gupta and Mani Srivastava seek to tackle the problem of overdesign by intentionally underdesigning hardware and using variability-aware software to mitigate the difference. Prof. Kang Wang is developing spintronics memories to overcome constraints as electronic devices shrink through the DARPA STT-RAM program. Prof. Ken Yang proposes new technology to extend the range of copper interconnects to meet limitations presented by current interconnect options.

■ Alternate forms of energy: Professors Chan Joshi and Warren Mori are investigating laser fusion as a replacement for traditional energy (such as oil). The Clean Green IGERT Fellowship program, led by Prof. Diana Huffaker, is shaping scientists and engineers in the area of clean energy.

Our quest for innovation has also pushed us to reach across disciplines. Professor Mihaela van der Schaar is leading the UCLA Center for Engineering Economics, Learning, and Networks. With funding support by Raytheon, Professors Izhak Rubin and Kung Yao have established the UCLA Public Safety Network Systems Laboratory to bring together experts from academia, industry and public safety agencies.

Technical societies have recognized achievements of our faculty and alumni. Professor Behzad Razavi was awarded the 2012 IEEE Donald O. Pederson Award in Solid-State Circuits for his contribution in high-speed CMOS communication circuits. Our alumnus Dr. Asad M. Madni (B.S. 1969, M.S. 1972) was elected to the US National Academy of Engineering (NAE), and was awarded the IEEE Instrumentation and Measurement Society's Career Excellence Award and the Lifetime Contribution Award by UCLA HSSEAS.

Recent graduates have accepted academic appointments, from West Virginia University and SUNY Buffalo, to Cairo University (Egypt), Yonsei University (South Korea) and National Chiao Tung University and National Tsing Hua University (Taiwan).

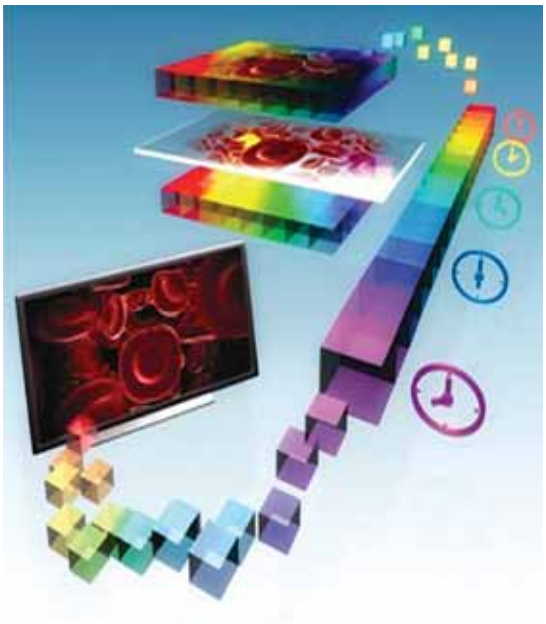
Our department is also set to welcome not only the largest freshmen class this Fall but also the largest graduate class as well — our reputation in research and education grow stronger than ever. It has been 20 years since we took on the name Electrical Engineering Department and we look forward to another 20 years of excellence. We proudly recognize the accomplishments of our faculty and their research groups, and thank our alumni, friends and customers in industry, government and academia for their continuous support.

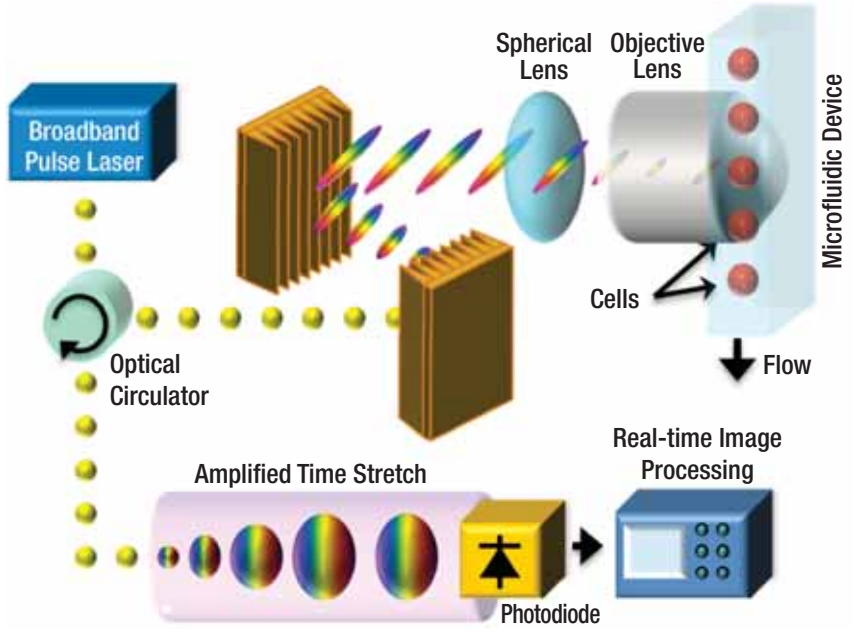
BLOOD SCREENING USING THE WORLD'S FASTEST CAMERA

Professor **Bahram Jalali**

Detection and isolation of rare events among a large heterogeneous population of cells is proving to be important for early detection of metastatic disease and for monitoring the efficacy of therapy. Rare cells that have a significant impact on medical diagnostics and therapeutics include stem cell transplantation, vaccine development, noninvasive prenatal diagnostics, angiogenesis research, and cancer diagnostics and therapy. Unfortunately, detection of such "rogue" cells with high statistical accuracy is difficult to perform due to the lack of technology with simultaneous high sensitivity and high throughput. While useful for visual inspection of single cells with high sensitivity, automated microscopy is prohibitively slow. On the other hand, flow cytometry has high throughput detection, but low sensitivity due to the lack of spatial resolution. Perhaps more importantly, the current flow imaging technology is not capable of real-time image processing even at the modest throughput with which it operates — almost 100x lower than necessary.

Professor Jalali and his group have developed a high-throughput flow-through imaging system for real-time detection of rare cells. This technology makes use of the group's photonic time stretch technology to create the world's fastest camera. The camera is then integrated with a cytometer and real-time image processing to classify every cell in a blood sample. The new blood screening technology boasts an unprecedented throughput of 100,000 cells per second, twice as fast as the current state-of-the-art automated microscopes. Overcoming the limitations that exist in the conventional methods, the UCLA technology can perform real-time detection of extremely rare cells in a large sample of normal cells with high sensitivity, specificity, and statistical accuracy in a very short period of time. With the help of Prof. Dino Di Carlo's group at UCLA Biomedical Engineering Department, the research has shown real-time identification of rare breast cancer cells in blood with a record low false-positive rate of one cell in a million. Preliminary results indicate that this new technology has the potential to enable detection of rare circulating tumor cells from a large volume of blood in a short time opening the way for statistically accurate early detection of cancer and monitoring efficacy of drug and radiation therapy.



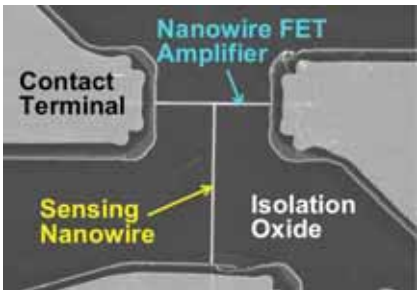


SEMICONDUCTOR ACTIVE BIOSENSORS AND BIOSENSING

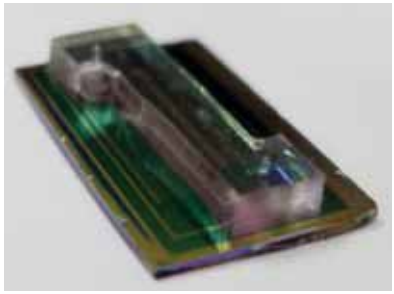
Assistant Professor **Chi On Chui**

Very low-cost and field-appropriate molecular-level detections for disease diagnostics, for instance, are sorely needed in both the civilian and military populations. The development and deployment of such point-of-care (PoC) in vitro diagnostic (IVD) platforms are however particularly challenging, especially in resource- limited settings, due to requirements such as high sensitivity and specificity, rapid turnaround time, absence of equipped facilities and trained personnel, low-cost of disposables and fixed equipments, portability, etc. As a key component inside these platforms, the biosensor is responsible for capturing the disease biomarker information and translating that into either a chemical or physical output signal. For highly selective detections or captures of these biomarkers, either antigen-antibody specific bindings or complementary nucleic acid hybridizations are widely adopted in common diagnostic platforms. The criteria on the signal transduction device technology include superior sensitivity, multiplex and simple operations, response timeliness, compactness, reusability, simple fabrication, and electronic interfaces.

As a contending platform technology, quasi-one-dimensional semiconductor nanowire field-effect transistor (FET) sensors have demonstrated label-free electronic detection of biomolecular analytes with sub-pM limit of detection (LOD). Moreover, their direct electrical outputs significantly simplify the subsequent signal processing and transmission versus the competing optical PoC solutions. These generic nanowire FET sensors, nevertheless, have severe limitations such as impractically low output signal levels at LOD, insufficient sensitivity, charge screening in high ionic strength solutions, and non-manufacturability. Besides sensitivity, the detection selectivity is often compromised by the platform-independent non-specific competitive binding events with interferents and/or random sensor surface biofouling.



Optical micrograph of a disposable electronic test strip prototype with handling fluidics for field-appropriate in vitro diagnostic (IVD) applications

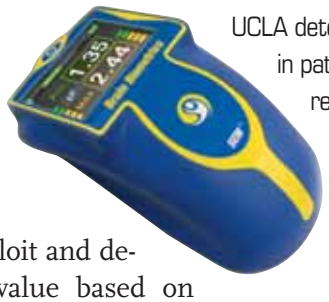


Scaning electron micrograph of the novel nanowire-based FET sensor invented in Professor Chi On Chui's laboratory

Leveraging the advanced semiconductor manufacturing technology, Professor Chi On Chui's laboratory is developing innovative semiconductor biosensor structures and their fundamental sensing principles. His laboratory has recently invented a nanowire-based FET sensor that electrically amplifies the biomolecular signals locally at the sensing source with minimally added noise. The "amplification-at-the-source" idea is analogous to that of a low-noise amplifier (LNA) in modern radio receiver circuits. Experimentally, the novel sensor prototypes have demonstrated 5-10 times sensitivity improvement in detecting solution pH value and cancer protein biomarkers over the conventional nanowire FET. In addition, his laboratory is developing innovative sensing procedures to mitigate simultaneously the screening and selectivity issues. In collaboration with cardiology clinicians at UCLA, his laboratory is prototyping IVD platforms (Figure 2) for highly sensitive, quantitative, and rapid diagnosis of time-critical cardiovascular disease such as acute myocardial infarction.

Professor Chui has received several awards for his work. Most notably, he is the first recipient of the IEEE Electron Device Society Early Career Award in 2009, which is regarded as one of the Society's highest honors. Very recently, he has also received the Chinese American Faculty Association Robert T. Poe Faculty Development Award.

WIRELESS HEALTH INITIATIVES



The SEM scanner developed at UCLA detects pressure ulcers in patients confined to bed rest or wheelchairs

Professor **William Kaiser**

Professor William Kaiser's research efforts have led to the development of the first sensor networks with Professor Gregory Pottie during the mid-90s, to energy efficient computing systems, and now to a new field formed first at UCLA: Wireless Health. Wireless Health combines the medical science and engineering disciplines that include biomedical sensing, signal processing, advanced sensor information processing theory and algorithms, embedded computing technology, the smartphone, and information technology. In collaboration with Dr. Bruce Dobkin (UCLA Neurology) and Majid Sarrafzadeh (UCLA Computer Science and Electrical Engineering), Professor Kaiser serves as a Director of the UCLA Wireless Health Institute (WHI).

Rapid advances this year at WHI are enabling the design of powerful clinic, home and mobile technologies that can assess disease, provide treatment guidance, and promote health, wellness, and fitness. The Signal Search Engine (SSE) research program has been developed to enable the combination of search and analytics required to exploit and deliver value based on this immensely valuable data resource. Highlights include the development of the Wireless Health Sensor Fusion Toolkit (WHSFT) now used in nearly all WHI programs including those to be described below. WHSFT employs new methods for signal processing feature extraction, sensor fusion classification, and context detection to enable both high accuracy classification of subject state as well as low energy and bandwidth efficient system operation.

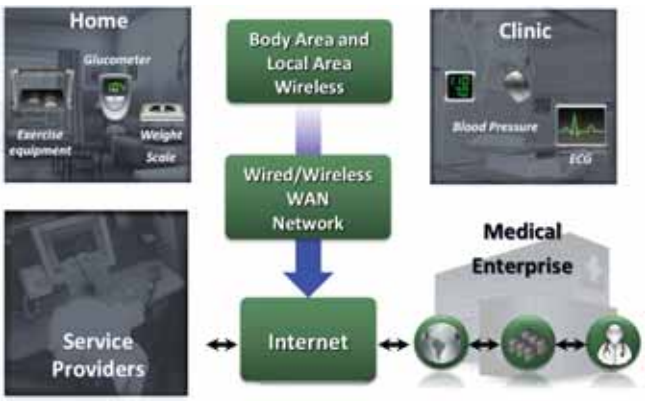
The Stroke Inpatient Rehabilitation Reinforcement of ACTivity (SIRRACT) trial has also started and enrolls 200 patients in 15 countries. The program has deployed inexpensive wearable motion sensor devices developed by the WHI team and employs the Signal Search Engine trained machine-learning algorithms that identify and characterize subject behavior and provide direct subject guidance.

Professor Kaiser's group has also led development of the UCLA Physiological Health Assessment System for Emergency Responders (PHASER) Program funded by the Department of Homeland Security. This was created to address a primary national objective to develop a breakthrough in assuring health and safety for the First Responder.

Finally, Professors Kaiser and Sarrafzadeh have led development of a new clinical instrument that provides the first evidence-based assessment of pressure ulcer wounds. This will serve a large population of patients in clinical treatment, to frail elder patients in residential and assisted living and nursing home environments who face the very important threat of pressure ulcers. These occur when subjects are confined to bedrest or wheelchairs and other constraints. The mortality rate from pressure ulcers is very high and accounts for over two million Medicate treatment days each year. The SEM Scanner, based on a novel probe of tissue dielectric properties, was developed in less than 18 months and is now deployed in trials and is being produced by a biomedical device manufacturing partner.

Professor Kaiser is also engaged in education initiatives where Wireless Health provides capstone design research opportunities for undergraduate and graduate courses.

These course projects have resulted in two conference best paper awards. Outreach includes the intensive support of the new Wireless Health conference series with the recent 2010 and 2011 editions. Professor William Kaiser provided the keynote address at the announcement media event by Ford Motor Company of its new Connected Health initiative on May 18, 2011 in Dearborn, Michigan. This is intended to provide Wireless Health support in Ford vehicles with wireless sensing and also with driver and passenger guidance services.

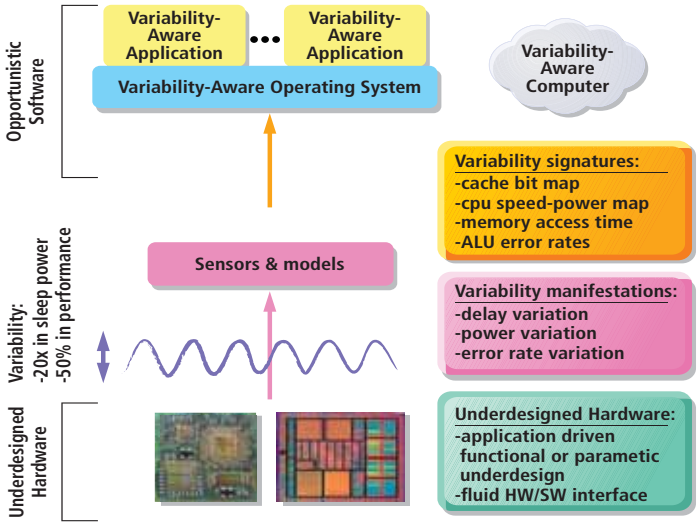


HARDWARE-VARIABILITY-AWARE SOFTWARE

Assistant Professor **Lara Dolecek**
http://www.algo.ee.ucla.edu

Assistant Professor **Puneet Gupta**
http://nanocad.ee.ucla.edu

Professor **Mani B. Srivastava**
http://nesl.ee.ucla.edu



As the semiconductor geometries scale down for exponential growth in capacity and capabilities of integrated circuits, the underlying logic and memory devices no longer behave like the precisely chiseled machines of the past. The variability in their behavior from device-to-device and over their lifetimes — due to manufacturing, aging-related wear-out and different operating environments — is completely ignored by modern computer systems. Through a recently awarded NSF Expedition in Computing project on Variability-Aware Software for Efficient Computing with Nanoscale Devices *(http://www.variability.org)*, Professors Dolecek, Gupta, and Srivastava's research groups are pursuing a new class of underdesigned and opportunistic computing machines. In these machines, the spatiotemporal variations, instead of being hidden behind conservative specifications of an 'over-designed' hardware, are exposed to the highest layers of software. An adaptable software stack then proactively conforms to the deliberately under-designed hardware with relaxed design and manufacturing constraints.

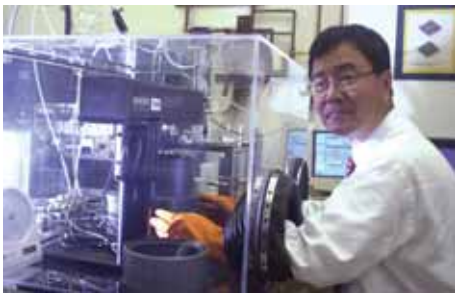
The Expedition project is a five-year, $10M, multi-university effort, jointly led by UCLA and UCSD, and also involving researchers from Illinois, Michigan, Stanford, and UC Irvine. The research will result in innovations in low-overhead mechanisms for online learning of hardware signatures; compact representations of hardware variability; application-intent driven underdesigned hardware design; variability-aware compilation; programming language support for variability; and, coordinated variability- aware adaptation in the operating system and applications.

Early results are promising. For example, work in Prof. Gupta's group has shown that in a video encoding system the hardware performance variations can be completely absorbed by application adaptation with imperceptible loss in image quality. In many cases, in functionally underdesigning hardware which deterministically commits errors, the results is acceptable as well. A joint work by Professsors Srivastava and Gupta leverages power variability in embedded processors by adapting duty-cycle of the running application by introducing an adaptable task abstraction in *TinyOS*, an OS commonly used in wireless sensor networks. The approach results in 22X improvement in average duty cycle, which directly translates to quality of sensor information, for ten measured commercial ARM Cortex M3 based systems.

In parallel Prof. Dolecek's students have proposed a family of error correction schemes that exploit, rather than ignore, the asymmetries in hardware variability. While simple to implement, the resulting methods already outperform previously best known results in terms of information capacity, and are particularly useful for emerging Flash memories.

The Expedition team has also undertaken an ambitious outreach effort to engage younger students for careers in computing and engineering. The team is mentoring high-school students as part of a new year-around "Los Angeles Computing Circle" (LACC) initiative. The inaugural ten-week Summer 2011 offering of LACC has engaged eight students from local high-schools in an intense program mentored by graduate and undergraduate students. It consists of short course modules on diverse computer engineering topics with hands-on implementation experience, and research projects spanning social network algorithms, embedded systems, robotics, and computer architecture.

SPINTRONIC MEMORY TECHNOLOGY AND GREEN NANO INITIATIVE



Distinguished Professor **Kang Wang**

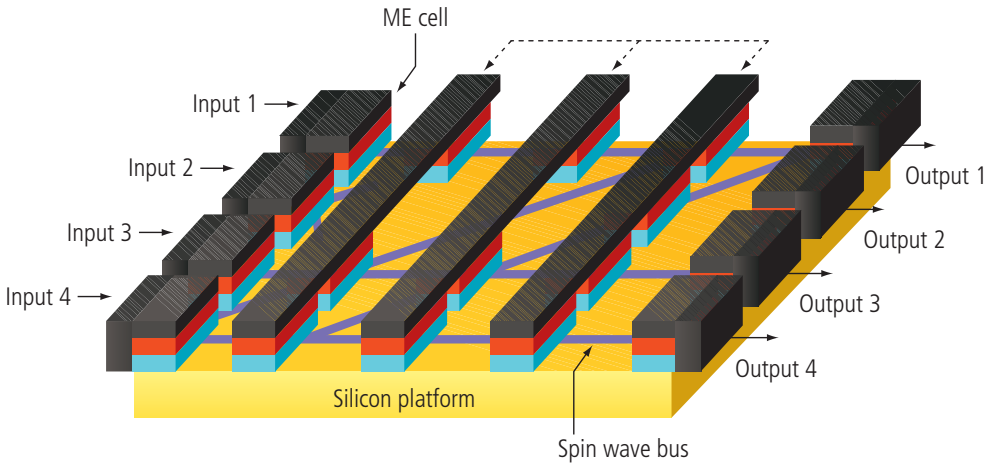
Professor Kang Wang has been leading two DARPA programs on nonvolatile spintronic memory and logic. The memory program aims at developing spin-transfer-torque magnetic random access memory (STT-RAM), while a second program aims to develop nonvolatile magnonic logic.

For his STT-RAM work, Kang Wang's team was awarded a $3 million Phase II award. The grant from the Defense Advanced Research Projects Agency (DARPA) funds research on a potential universal memory. The agency had previously awarded UCLA Engineering $5 million for the first phase of this research program. STT-RAM can achieve a density comparable to dynamic random access memory (DRAM), and it equals — and has even exceeded — the high speed of static random access memory (SRAM), which is often used for caches in computer microprocessors. And like the flash memory common in USB drives and memory cards, STT-RAM retains its memory without any power while being orders of magnitude faster and more energy efficient. STT-RAM could combine these three advantages into a single scalable memory technology with excellent endurance and very low power requirements.

Professor Wang was also awarded an additional $4 million Phase I award for research on a technology known as non-volatile logic, which enables "instant-on computation." Today's digital electronics rely on complementary metal-oxide semiconductor (CMOS) integrated circuits, which use an electron's charge to store and transfer information. But as devices and chips have become smaller and more compact, the fundamental limits of CMOS are being approached. The emerging field of spintronics exploits another aspect of electrons — their spin — to transfer information, taking advantage of ferromagnetic materials. Devices using magnetic materials can be nonvolatile, maintaining their state even when power is removed, and consume much less power when switched on.

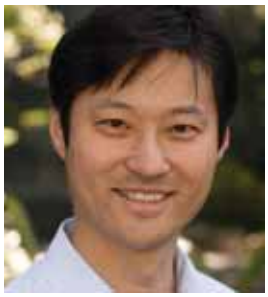
In addition, National Institute of Standards and Technology awarded UCLA's Henry Samueli School of Engineering and Applied Science $6 million to support the construction of the new state-of-the-art Western Institute of Nanotechnology on Green Engineering and Metrology (WIN-GEM). The new building will provide core research facilities, supporting research on low-power, nonvolatile nanoelectronics; green manufacturing of novel nanomaterial-based energy technologies; and new materials for energy generation, storage and management. The Western Institute of Nanoelectronics, led by Professor Kang Wang, is one of the centers of excellence to be housed in WIN-GEM. It is a consortium of major semiconductor companies addressing the needs of electronics beyond today's mainstream CMOS technology.

The Western Institute of Electronics and the Center on Functional Engineered Nano Architectonics (FENA) — another center of excellence led by Kang Wang, which explores low-cost, high-yield, energy-efficient nanoscale manufacturing technologies for semiconductor devices — have more than 80 principal investigators in the U.S. in addition to those at UCLA. FENA will also be located in WIN-GEM.



UCLA's nonvolatile logic concept uses waves of magnetization, referred to as spin waves or magnons, to perform logic operations, while magnetic memory bits are used to add nonvolatility to the circuit

GREEN INTERCONNECTS FOR INTRA DATA-CENTER COMMUNICATION



Professor **Chih-Kong Ken Yang**

As data centers are expected to manage the increasing demands in bandwidth, processing power and storage requirements, connectivity issues between blades/racks present a whole new set of challenges in maintaining a stable infrastructure. While data centers may grow to occupy thousands of square feet, current passive copper interconnects pose a real limitation with a run length of 10 meters at 10Gbps per wire pair. Optical fiber can extend the interconnection length from 10 meters to 100 meters, but the large power requirements and expensive opto-electric modules prove to be too uneconomical for practical application. As a compromise, through the use of the Infiniband standard, a 12Gbps cable link can be achieved that would extend the range of copper interconnects beyond the 100 meter threshold.

The research conducted with graduate student researcher, Tamer Abdelrahim, proposes a link that leverages synchronous clock forwarding on one available data channel that improves jitter tracking, while greatly simplifying the design of the receiver and timing recovery circuits. Only a phase de-skewing is required at the receive side to retrieve the clock-data relationship. In the cable link architecture, the 12 Gbps data is repeated in 8 meter sections with clocking forwarding on a dedicated channel. Then the forwarded clock is dropped off every data repeating stage in order to be multiplied to half the data rate and be used to strobe the incoming data. The longer the quality of clock forwarding is maintained, the cleaner the data strobed at each repeater and the longer the cable can be extended. At each repeater, the clock resets the jitter accumulated from the previous repeater, allowing for data transmission with as much jitter as in the strobing clock.

Networking physical limitations is the focus of Professor Yang's laboratory. Signal repeaters can extend the curent copper links in data centers to over the 100 meter limitation

Determining a fine balance in forward clock frequency is crucial in defining jitter performance of the cable link. Frequency beyond the cable bandwidth results in large attenuation of clock amplitude creating more noise and jitter accumulation along clock repeater. On the other hand, frequency well below the cable bandwidth will increase jitter accumulation time and will degrade jitter performance inside the clock multiplier. The trade-off between low frequency clock jitter accumulation in the Clock Multiplication Unit (CMU) and the high frequency jitter accumulation along the clock repeaters is one of the defining aspects of optimizing the active copper link.

To further reduce the clock jitter accumulation across repeaters, phase interpolation between the input clock and the divided output of the CMU is used to generate the forward clock for the next repeater stage. The addition of the phase interpolator has negligible power/area cost, dramatically reduces jitter accumulation, and adds another degree of flexibility in choosing the forwarded clock to reduce the total accumulated jitter. With the proper choice of forward clock frequency, application of the FIR filtering technique and a high performance CMU, a total run length of 115 meters is achieved.

LASER FUSION: AN INEXHAUSTIBLE ENERGY SOURCE FOR THE FUTURE

Professor **Chandrashekar Joshi**
Professor **Warren Mori**

The continued prosperity of mankind depends on access to energy at a reasonable price. As oil and other fossil fuels either run out or their continued use poses unacceptable environmental risks, mankind must resort to an alternate source of energy that is clean, abundant and able to supply the bulk of the world's energy needs. With this goal in mind, researchers have been working on replicating nuclear fusion that occurs in the Sun — a process called laser fusion.

In laser fusion, a few mm diameter sphere containing deuterium (D) and tritium (T), two isotopes of hydrogen, is imploded by vaporizing its outer surface using either intense laser beams or laser-generated x-rays. The fuel density and temperature rise while its radius shrinks during the implosion process until collisions between D and T ions leads to fusion and energy is released. After nearly four decades of work, researchers at the National Ignition Facility at Lawrence Livermore Laboratory in California are on the threshold of demonstrating a net energy gain from a laser fusion pellet.

In order for laser fusion to work, the laser energy must go where it is aimed. It cannot be reflected, bent, or absorbed by laser-plasma instabilities before reaching its target. Professors Joshi and Mori have been working on understanding the fundamental science behind laser-plasma interactions for 30 years.

From the early days of laser fusion, Professor Joshi's research group has carried out fundamental laser-plasma interaction experiments and theory to explain the processes by which the laser light is absorbed and scattered by the plasma. This showed that when high intensity laser pulses enter the plasma, non-linear processes called stimulated Brillouin and Raman instabilities scatter light out of the plasma. This can significantly reduce the amount of laser light that is absorbed. Their work also showed that Raman scattering accelerates very high-energy electrons. If these electrons penetrate the laser-fusion capsule, they can preheat the DT fuel thereby preventing efficient compression of the fuel that is needed to trigger fusion reactions.

UCLA experiments showed how Brillouin scattering could be controlled to manageable levels by using plasmas that contained a small concentration of lighter ions. The space-charge density waves generated by Brillouin and Raman scattering interact with one another and with electrons and ions in the plasma. The presence of an ion wave characteristic of Brillouin scattering for instance can dampen the electron plasma wave generated by Raman scattering. Other experiments showed that when two laser beams cross one another in plasma, energy can be transferred from between the beams. All these findings have relevance to the national laser fusion program.

Neptune Lab. World's most powerful CO_2 laser is used for non-linear effects present in laser fusion plasmas

Professor Mori's research group has been studying Stimulated Raman Scattering and the two-plasmon decay processes, and how small changes to the electron distribution function can dramatically change the laser-plasma interactions including the reflectivity. They are also studying how large amplitude plasma wave packets excited by either Stimulated Raman Scattering and/or two plasma decay can modify the reflectivity and also lead to very energetic electrons.

Currently, Professor Chan Joshi's group has the world's most powerful CO2 laser system in the world. Professor Mori's group has its own powerful computer cluster (called Dawson2) that is the 148th fastest computer in the world. His group also has its own computer code, OSIRIS, that is ideal for studying laser-plasma processes. UCLA is one of only a handful of universities offering graduate student training in this area. Our faculties serve on important committees that review the national program in energy research.

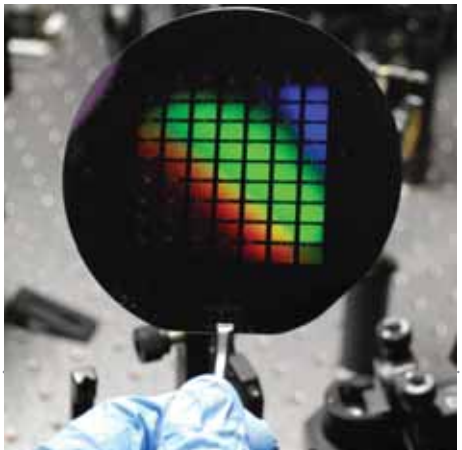
INTEGRATED NANOMATERIALS LABORATORY

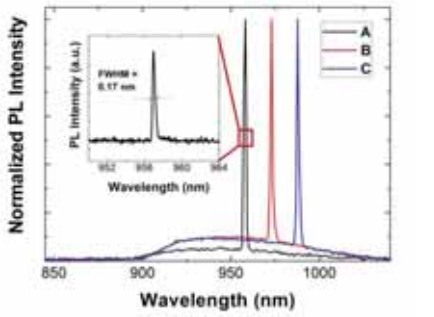
Professor **Diana Huffaker**

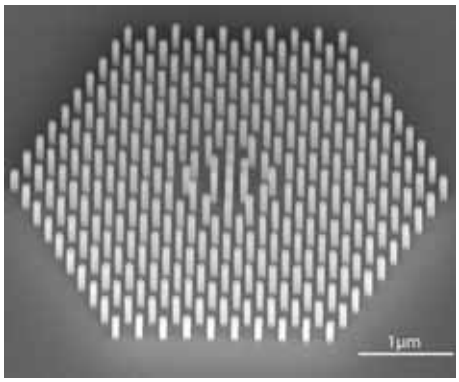
In general, semiconductor nanotechnology strives to develop new approaches to atomic arrangement to enable enhanced absorption and emission of light along with efficient current conduction. The fundamental technology of the Integrated Nanomaterials Laboratory (INML) at CNSI is based on directed assembly of crystallographic semiconductor materials atom-by-atom to form quantum nanostructures such as quantum dots and nanopillars. The synthesis methods are based in molecular beam epitaxy and metalorganic chemical vapor epitaxy specializing in compound III-V materials including III-As, Sb and N. Directed by Professor Diana Huffaker, the INML research group has developed several unique approaches to realize materials with very specific characteristics in emission wavelength, absorption spectrum, carrier dynamics. This material combination offers access to the full spectrum ranging from ultraviolet to infrared. In particular, Huffaker and her group have patented several techniques to specify and control nanowire placement and dimension using a lithographically predetermined pattern. This is very powerful for realizing real devices from nanowires, especially.

The nanomaterials, quantum dots and nanowires, produce a lot of excitement worldwide due to several intriguing properties. The associated quantized density of states enable highly efficient light absorption for photovoltaics, effective electron-hole pair storage and release for optical memory along with potentially important solutions for silicon integration. Nanostructured materials have a much larger surface-to-volume ratio compared to bulk, so they interact with electricity and light in a very different way. Furthermore, they are more reactive than larger particles, which opens up new areas of study merging chemistry, physics, and biology. Since joining UCLA, Huffaker has become increasingly interested in the interaction between organic and inorganic matter for new materials discovery and revolutionary device development. This approach results in highly inter disciplinary research efforts fostered by a strong collaborative network — within UCLA and around the globe — to solve fundamental problems in communication, energy and health.

Along with CNSI, Huffaker's strongest UCLA collaborative network is the Clean Green IGERT (CGI) Fellowship program sponsored by the National Science Foundation and the American Recovery and Reinvestment Act. The CGI trains Ph.D. scientists and engineers for leadership roles in the clean energy sector. Technical thrusts include energy harvesting, storage, conservation solutions and energy policy comprising faculty across Engineering, Chemistry and Institute of the Environment. Community participation is a CGI cornerstone with emphasis on volunteer work throughout Los Angeles and high school outreach, including an "energy science roadshow." CGI has fostered many fruitful cross-campus research programs through fellowship support and seed-funds along with new clean energy coursework cross-listed in Engineering and College of Arts and Letters.







Semi-conductor materials are built, atom-by-atom: Patented nanowire placement control and nanopillars at INML.

CENTER FOR ENGINEERING ECONOMICS, LEARNING, & NETWORKS

Professor Mihaela van der Schaar

The UCLA Center for Engineering Economics, Learning, and Networks is developing a new wave of ideas, technologies, networks, and systems that change the ways in which people (and devices) interact, communicate, collaborate, learn, teach, and discover. The Center brings together an interdisciplinary group of researchers from diverse disciplines — including computer science, electrical engineering, economics, and mathematics — with diverse interests spanning microeconomics, machine learning, multi-agent systems, artificial intelligence, optimization, and physical and social networks, all sharing a common passion: developing rigorous theoretical foundations to shape the design of future generations of networks and systems for interaction.

Formal activities of the Center will begin in Fall 2011 with a one-day inaugural colloquium; details to be announced. Other planned activities include a day of tutorials by affiliated faculty and a biweekly seminar series featuring talks by both internal and external researchers.

UCLA Center for Engineering Economics, Learning, and Networks is composed of people from UCLA Department of Electrical Engineering, Computer Science and Economics. Current members are: Prof. Simon Board (Economics), Prof. Adnan Darwiche (Computer Science), Prof. Moritz Meyer-ter-Vehn (Economics), Prof. Ali H. Sayed (Electrical Engineering), Prof. Paulo Tabuada (Electrical Engineering),Prof. Jenn Wortman (Computer Science) and Prof. William Zame (Economics). Prof. Mihaela van der Schaar from Electrical Engineering is the Center's Director.

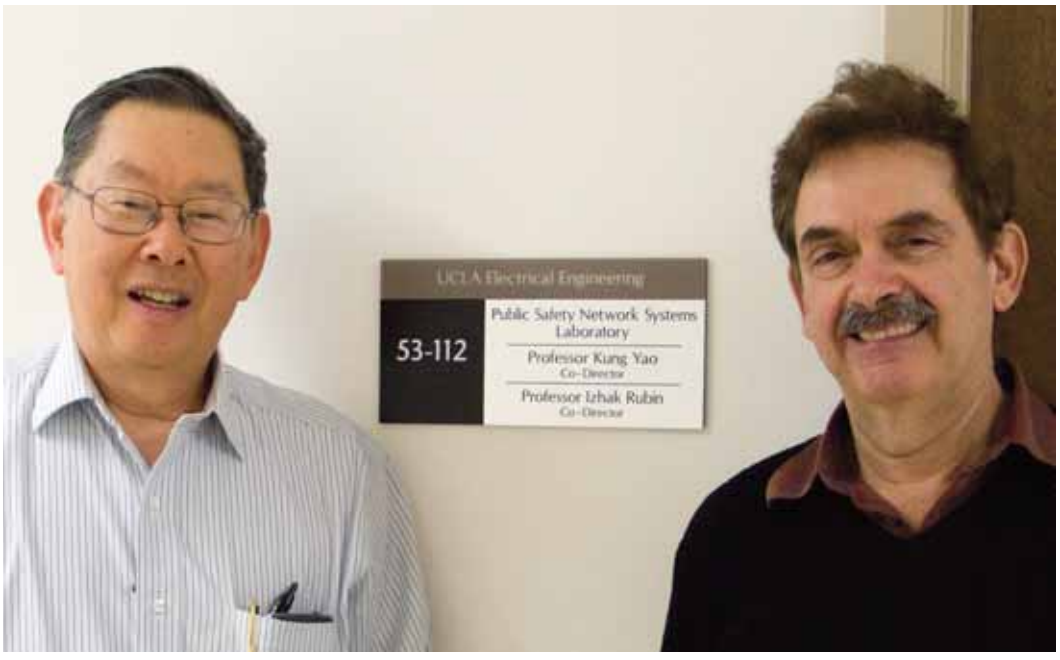
UCLA PUBLIC SAFETY NETWORK SYSTEMS LABORATORY

Distinguished Professor **Kung Yao**
Distinguished Professor **Izhak Rubin**

In February 2011, Raytheon Company gave a seed funding of $1 million for three years to UCLA for its partnership to create a new Public Safety Network Systems Laboratory (PSNSL). The mission of this Laboratory is to bring together academia, industry, and public safety agencies to provide technical leadership to perform collaborative research and to establish standards for public safety networks based on the 4G LTE — Advanced standards.

The co-directors of the Laboratory are Distinguished Professor Kung Yao and Distinguished Professor Izhak Rubin of the Electrical Engineering Department in the Henry Samueli School of Engineering and Applied Science (HSSEAS). This Laboratory is affiliated with the Institute for Technology Advancement (ITA) at UCLA.

Six broad areas of PSNSL efforts include: Area 1. Develop a CONOPS for Public Safety Network and Operations Technologies; Area 2. Develop Reference Model for Public Safety; Area 3. Develop Technologies Including LTE – Advanced; Area 4. Develop Device Technologies; Area 5. Perform Interoperability Studies; Area 6. Perform Interoperability Testing.



Professors Yao and Rubin, co-chairmen, in front of the new research center Public Safety Network Systems Laboratory, funded by Raytheon

RAZAVI RECEIVES THE IEEE PEDERSON AWARD IN SOLID-STATE CIRCUITS

Professor **Behzad Razavi**

Professor Behzad Razavi is the recipient of the 2012 IEEE Donald Pederson Award in Solid-State Circuits, the highest award accorded to an individual in the field of integrated circuits.

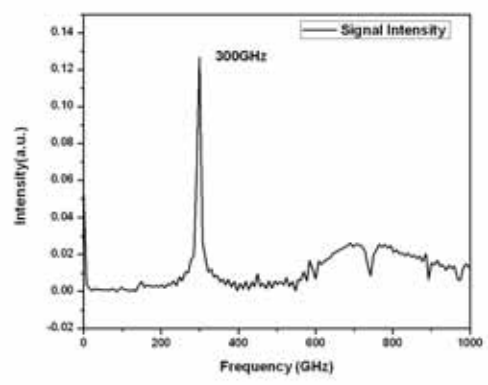
An award-winning scholar, author, and teacher, Prof. Razavi has, for two decades, continued to push the speed of communication transceivers in standard CMOS technology. The new architectures, circuits, and devices developed in the course of his research have paved the way for many of today's integrated wireless and wireline systems. Professor Razavi is also known for his theoretical and modeling studies, which have explored and elucidated the underlying principles of many devices and circuits.

Prof. Razavi's work in the area of wireless transceivers has pioneered the concept that innovations at the architecture level can greatly relax the design at the circuit level. He and his students have explored new architectures for RF applications from 900 MHz to 60 GHz, introducing, for example, "synthesizer-friendly" transceivers. Such architectures have substantially simplified the design of their constituent oscillators and frequency dividers, leading to 60-GHz receivers and transmitters that consume the lowest reported power levels.

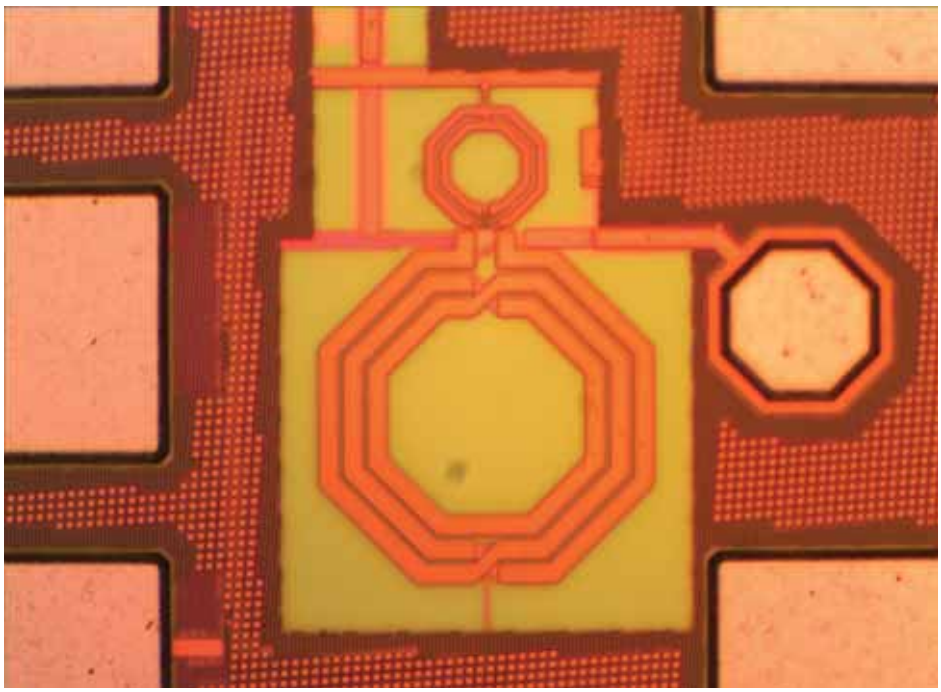
Prof. Razavi has also made seminal contributions to wireline systems, specifically, in the area of high-speed phase-locked systems and broadband circuits. A unique aspect of Prof. Razavi's work has been the ability to leverage concepts from the RF design world to wireline circuits. Utilizing new techniques, he and his students were the first to demonstrate 10-Gb/s and 40-Gb/s clock and data recovery (CDR) circuits, laser drivers, and equalizers in CMOS technology, creating the impetus for the design of wireline transceivers in CMOS. Prof. Razavi's research has recently led to techniques that afford 300-GHz fundamental oscillation in 65-nm CMOS.

Prof. Razavi is also known for his lucid teaching and writing style. His exemplary teaching has excited and inspired thousands of students, and his books — translated to Chinese, Japanese, Korean, and Portuguese — have been read and loved by more than one hundred thousand students and engineers.

Prof. Razavi has received numerous awards for his research, authorship, and teaching. He has served as an IEEE Distinguished Lecturer and was selected as one of the top ten authors in the 50-year history of the International Solid-State Circuits Conference.



A 300-GHz fundamental oscillator developed by Prof. Razavi along with its measured spectrum



NAE MEMBERSHIP AND IEEE CAREER EXCELLENCE AWARD

Dr. Asad M. Madni (1969, M.S. 1972), Chair of the EE Alumni Advisory Board and President of the UCLA Engineering Alumni Association was elected to the U.S. National Academy of Engineering (NAE) "for contributions to development and commercialization of sensors and systems for aerospace and automotive safety." Election to the NAE is the highest professional distinction that can be accorded an engineer. The NAE is a private, independent, nonprofit institution that provides engineering leadership in service to the nation. Its mission is to promote the technological welfare of the nation by marshaling the expertise and insights of its members in the engineering profession. Members are elected to the academy by their peers for having distinguished themselves in research, technical positions and leadership in industry, government and academia.

Dr. Madni was also awarded the 2010 "Lifetime Contribution Award" by the

Distinguished Professor **Asad Madni**

UCLA Henry Samueli School of Engineering and Applied Science. "This highly selective and prestigious award honors an alumnus or friend of the School who has made outstanding and extraordinary contributions to the field of Engineering and the School over the course of his or her lifetime."

Additionally, Dr. Madni is the recipient of IEEE Instrumentation and Measurement Society's highest honor, the 2010 Career Excellence Award "for an extraordinary career of enlightened leadership in and pioneering contributions to the development and commercialization of intelligent sensors, systems and instrumentation."

Alumni 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.

Sharon Black
Special Projects
Program Director
Raytheon

Leonard Bonilla
Retired
Raytheon

David Doami
Director, Program Manager
Northrop Grumman

Vicky Gih
Design Engineer &
Product Lead
Northrop Grumman

Dan Goebel
Senior Research Scientist
Jet Propulsion Laboratory

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

Bob Green
Attorney
Christie, Parker,
and Hale, LLP

Sharon V. Hong
Systems Integration
Specialist
Motorola

Gigi Lau
Engineer Alumni

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

Student Awards 2010

These awards were given to students for their academic excellence and contributions to the department and school.

Christina Huang Memorial Prize
Raymond Liou

The Russell R. O'Neill Distinguished Service Award Recipient
Raymond Liou

Outstanding Senior Award
Raja A. Gangopadhya

Engineering Achievement Award for Student Welfare Recipients
Chia Heng Chang, *B.S., Spring 2011*
Tran Dam, *B.S., Winter 2011*
Melissa Sue Erickson, *B.S., Fall 2011*
Susan Huon, *B.S., Fall 2011*
Raymond Liou, *B.S., Winter 2011 (above)*

2010-2011 Excellence in Teaching Award
Thomas Courtade
Pei-Chi Jiang
Seyed Arash Mirhaj
Zicong Zhou
with Chairman Frank Chang (left)

Outstanding Master of Science Award
Dustin Torres
Advisor: Prof. Mani Srivastava

Distinguished MS Research in Circuits & Embedded Systems
Dustin Torres

Distinguished PhD Dissertation in Circuits & Embedded Systems
Chia-Hsiang Yang
Advisor: Prof. Dejan Markovic (left)

Outstanding Doctor of Philosophy Award
Harish Rajagopalan
Advisor: Prof. Yahya Rahmat-Samii (left)

Distinguished PhD Dissertation in Physical & Wave Electronics
Harish Rajagopalan
with Chairman Frank Chang (right)

Members of National Academies

Asad A. Abidi

National Academy of Engineering

In 2007, Professor Asad A. Abidi was inducted into the National Academy of Engineering for his contributions to the development of MOS integrated circuits for RF Communications. Prior to joining UCLA in 1985, Professor Abidi worked at Bell Laboratories, 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 by the IEEE, 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. His research focuses on 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 holds the Jonathan B. Postel Chair in Computer Networking. Elected to the National Academy of Engineering in 2009, Professor 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 National Science Foundation research center, which brings together dozens of researchers from multiple universities and serves as a model for other federally funded centers. Professor Estrin 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 the interdisciplinary electromagnetics research beyond traditional electromagnetic engineering. He was elected to the National Academy of Engineering in 2003, "for seminal contributions in advancing electromagnetic engineering for microwave and wireless components, circuits, and systems". He developed several numerical methods to understand microwave problems, and developed the first CAD program package for designing E-plane filters for millimeter wave systems. His research focuses in combining solid state devices and electromagnetic circuits for cost-effectiveness and system performance, developing the first global simulator for the RF frontend, dealing simultaneously with antennas, passive and active microwave circuits. He also created the Active Integrated Antenna scheme in which the antenna is not only a radiating element, but also a circuit element for the RF front end.

Kuo-Nan Liou

National Academy of Engineering

Professor Kuo-Nan Liou is director of the Joint Institute for Regional Earth System Science and Engineering (JIFRESSE). Professor Liou pioneered the use of combinations of remote sensors to obtain important cloud ice and aerosol parameters and climate radiative forcing. He derived the analytic four-stream solution for radiative transfer and discovered the depolarization principle to differentiate ice crystals and water droplets. Professor Liou was elected a Member of the National Academy of Engineering in 1999

and was a past Chair of its Special Fields and Interdisciplinary Engineering Section (2008-2010). Elected a Member of the Academia Sinica (Chinese Academy of Sciences, Taiwan) in 2004, Professor Liou is also a Fellow of the American Association of the Advancement of Science, AGU, AMS and OSA. He received the Jule Charney Award from AMS and a creativity award from NSF, and shared the Nobel Peace Prize bestowed on the Intergovernmental Panel on Climate Change (IPCC) in 2007. Professor Liou was the recipient of the 2010 COSPAR William Nordberg Medal.

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. 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 made numerous seminal contributions in 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

Distinguished 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, he was a Senior Research Scientist at Jet Propulsion Laboratory. 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, Urbana-Champaign. He holds the Northrop Grumman Chair in Electromagnetics.

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 and 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 is a professor in the Electrical Engineering Department. He is also well known as the co-founder of Broadcom Corporation. In 2010, Professor Samueli received the UCLA Medal.

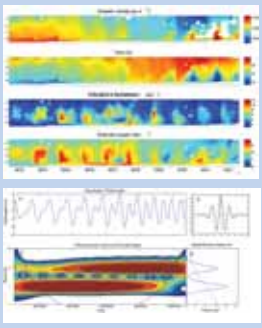
Jason Speyer

National Academy of Engineering

Professor 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 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 for aircraft fuel-optimal cruise and endurance. His efforts in differential carrier phase GPS blended with an inertial navigation system was applied to flight 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 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.



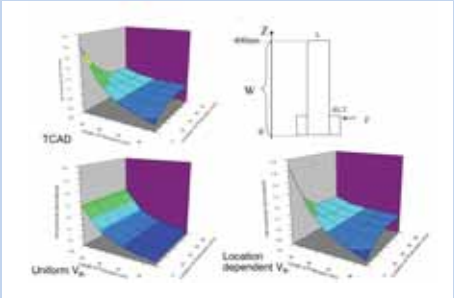
http://www.cens.ucla.edu

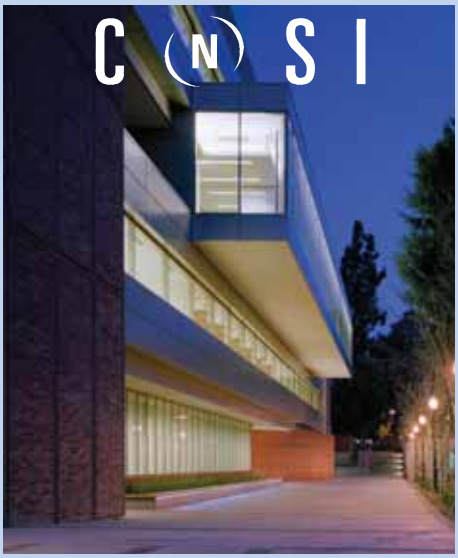
Expedition into Hardware-Variability-Aware Software

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.

Please see page 11 for more information.

http://www.variability.org





California NanoSystems Institute (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 $850 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

FCRP Center on Functional Engineered Nano Architectonics

FENA

Focus Center
RESEARCH PROGRAM

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 a multidisciplinary center that is the world's largest spintronic research effort. WIN was established in 2006 and is headquartered at UCLA, led by Electrical Engineering Professor Kang Wang. The institute involves collaborations among various Californian Universities which includes Stanford, Berkeley and UCLA. The institute's mission is to explore and develop advanced research devices, circuits and nanosystems with performance beyond CMOS devices. The Institute was established with funding totaling over $20 million in addition to spinning the STTRAM and NV Logic DARPA programs at UCLA totaling over about $16M. Furthermore, through these research efforts NIST awarded UCLA $6M to build the WIN-GEM building as part of the Engineering Building 1 replacement. WIN industry partners and consortia are organized through the Nanoelectronics Research Initiative which includes semiconductor companies such as Intel, IBM, Texas Instruments, NIST, Globalfoundries and Micron.

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 are working together under a established Center of Excellence in Green Nanotechnology to promote educational, technology transfer 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 is the nation's premier national laboratory. 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 integratedactive optoelectronics on silicon
- Carbon nanotube circuits

Please See Also:
Wireless Health Institute.....page 8
Center for Engineering Economics, Learning & Networks.....page 12
Public Safety Network Systems Laboratory.....page 13

The Electrical Engineering Department Overview

Faculty and Staff

Ladder Faculty	45 FTEs
Courtesy Appointments	14
Emeriti Faculty	13
Adjunct	6
Lecturers	13
Staff	42

Recognitions

Society Fellows	33
NAE Members	8
NAS Members	2
National Medal of Science	1

Research Facilities

Laboratories and Research Groups: 37
Space: 100,772 square feet

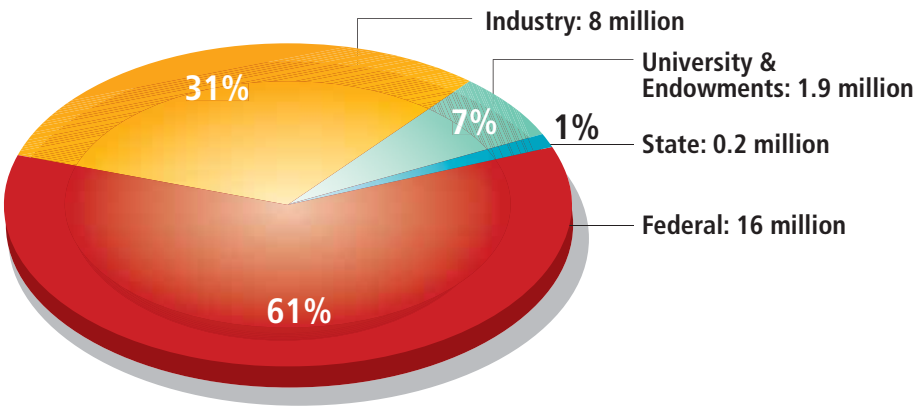
Research Centers

The Electrical Engineering Department contributes to the following Research Centers:

California NanoSystems Institute (CNSI)
Center for Embedded Networking Sensing (CENS)
Center for Engineering Economics, Learning & Networks
Center for Excellence in Green Nanotechnology
Center for High Frequency Electronics (CHFE)
Center for Systems, Dynamics and Controls (SyDyC)
Expedition into Hardware Variability-Aware Software
Functional Engineered Nano Architectonics Focus Center (FENA)
Institute for Cell Mimetic Space Exploration (CMISE)
Institute for Digital Research and Education (IDRE)
Institute for Pure and Applied Mathematics (IPAM)
Institute for Technology Advancement (ITA)
Nanoelectronics Research Center (NRC)
Public Safety Network System (PSNS)
Water Technology Research Center (WaTer)
Western Institute of Nanotechnology (WIN)
Wireless Health Institute

Research Funding for 2010-2011:

$ 26.2M



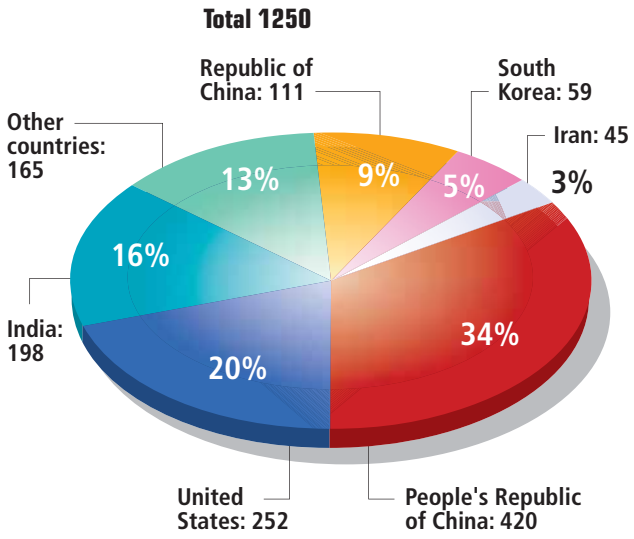
Undergraduate Students

Students Enrolled	732
Applicants	1036
Admitted	439
New Students Enrolled	150
Average Freshman GPA	3.83

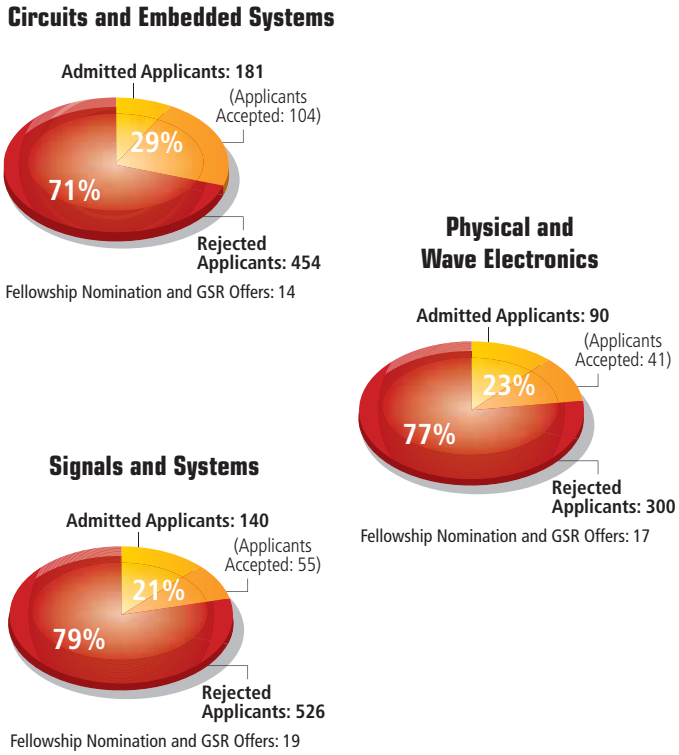
Graduate Students

Students Enrolled	404
Applicants	1250
Admitted	411
New Students Enrolled	147
Average Incoming GPA	3.71

Graduate Applicants for Fall 2010



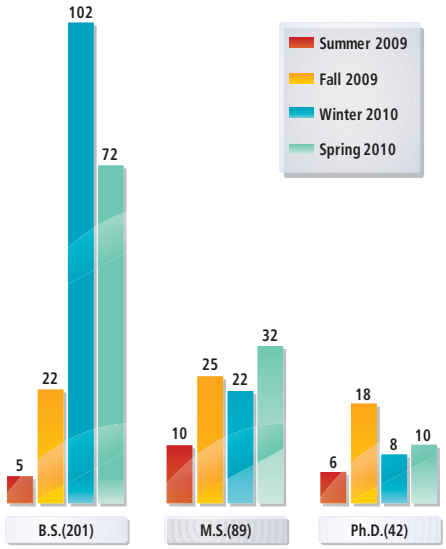
Graduate Students Admitted



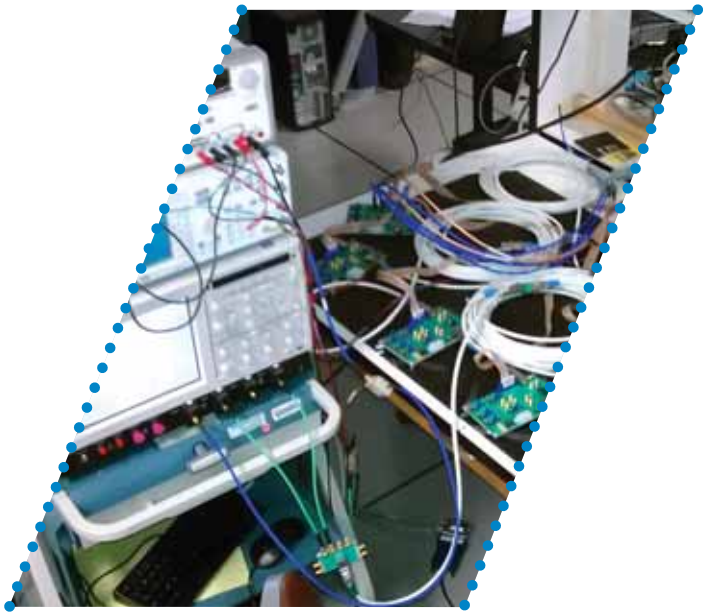
Graduate Students Fellowships

Department Fellowships	$547,646
Non-Resident Tuition Support for Teaching Assistants	$195,920
Dean's GSR Support	$140,469
Dissertation Year Fellowships	$94,056
Eugene Cota Robles Fellowship	$78,982
Faculty Unrestricted Fellowships	$73,387
Ph.D. Preliminary Exam Top Score Fellowships	$54,337
Henry Samueli Partial Fellowships	$53,744
Graduate Opportunity Fellowship	$42,683
Chancellor's Prize	$30,000
Dean's Fellowship & Campu Funds	$28,500
Dr. Ursula Mandel Fellowship	$15,000
Guru Krupa Foundation Fellowship	$2,500
Living Spring Fellowship	$2,500
Conference Travel Funds	$1,200
TOTAL	$1,360,924

Degrees Conferred in 2010-2011



Circuits and Embedded Systems



Asad A. Abidi

Distinguished Chancellor's 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
- IEEE Donald Pederson Award, 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.

- Okawa Foundation Award, 2009
- Samueli Fellow, 2008

M.C. Frank Chang

Distinguished Professor and Chairman
Wintek Professor of Electrical Engineering
Ph.D., National Chiao-Tung University, Taiwan, R.O.C., 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
- IEEE David Sarnoff Award, 2006
- Fellow, IEEE, 1996

Jason Cong

Chancellor's Professor
Ph.D., University of Illinois at Urbana-Champaign, 1990

Synthesis of VLSI circuits and systems, programmable systems, novel computer architectures, nano-systems, and highly scalable algorithms.

- ACM/IEEE A. Richard Newton Technical Impact Award in Electric Design Automation, 2011
- ACM Fellow, 2008
- Fellow, IEEE, 2000

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

Distinguished Professor
Jonathan B. Postel Professor of Networking
Ph.D., Massachusetts Institute of Technology, 1985

Participatory Sensing, Mobile Health, Environmental monitoring, Open systems, Privacy.

- National Academy of Engineering, 2009
- Anita Borg Institute's Women of Vision Award for Innovation in 2007
- Fellow, AAAS, 2001

Puneet Gupta

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

Optimizations across application, architecture, circuit and fabrication interfaces for nanoscale semiconductor technologies. CAD techniques to enable design aware manufacturing and manufacturing aware design. VLSI physical design automation.

- ACM/SIGDA Outstanding New Faculty Award, 2010
- SRC Inventor Recognition Award, 2010
- NSF CAREER Award, 2009

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.

- Northrop Grumman Excellence in Teaching Award, 2005
- IBM Faculty Award, 2003
- NSF CAREER Award, 2000

William J. Kaiser

Professor
Ph.D., Wayne State University, 1984

Development of networked embedded computing for linking the Internet to the physical world. Distributed and wearable systems for advancing the quality and international accessibility of healthcare through Wireless Health.

- UCLA Gold Shield Faculty Prize, 2009
- Brian P. Copenhaver Award, 2005
- Allied Signal Faculty Research Award, 1995

Dejan Markovic

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

Power/area-efficient digital integrated circuits for communication and healthcare applications, design with post-CMOS devices, design optimization methods and supporting CAD flows.

- NSF CAREER Award, 2009
- David J. Sakrison Memorial Prize, UC Berkeley, 2007

Sudhakar Pamarti

Associate Professor
Ph.D., University of California, San Diego, 2003

Mixed-signal IC design: wireless/wireline communication applications, digitally assisted analog/RF circuit design, delta-sigma modulation, quantization noise theory.

- NSF CAREER Award, 2010

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.

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.

- UCLA Senate Teaching Award, 2007
- 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 high-speed 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.

- Co-Director, UCLA Wireless Health Institute, since 2008
- Co-Founder, four Startups, since 2000
- Fellow, IEEE, 1996

Mani B. Srivastava

Professor
Ph.D., University of California, Berkeley, 1992

Embedded and Cyber-Physical Systems; Distributed and Participatory Sensing; Mobile, Wearable, and Pervasive Computing; Wireless Networks; Power & Energy-aware Systems; Energy Harvesting Technologies; Applications in mHealth, Green Buildings, and Smart Grids.

- Fellow, IEEE, 2008
- Okawa Foundation Grant Award, 1998.
- NSF CAREER Award, 1997

Alan N. Willson, Jr.

Distinguished Professor
Charles P. Reames Endowed Professor of Electrical Engineering
Ph.D., Syracuse University, 1967
** Also at Signals and Systems*

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

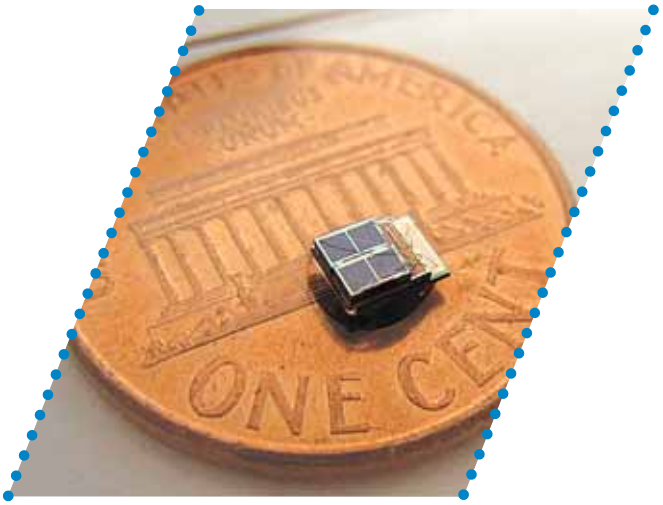
- IEEE Leon Kirchmayer Graduate Teaching Award, 2010
- IEEE W. R. G. Baker Award in Signal Processing, 1985 and in Circuits, 1994
- Fellow, IEEE, 1978

Chih-Kong Ken Yang

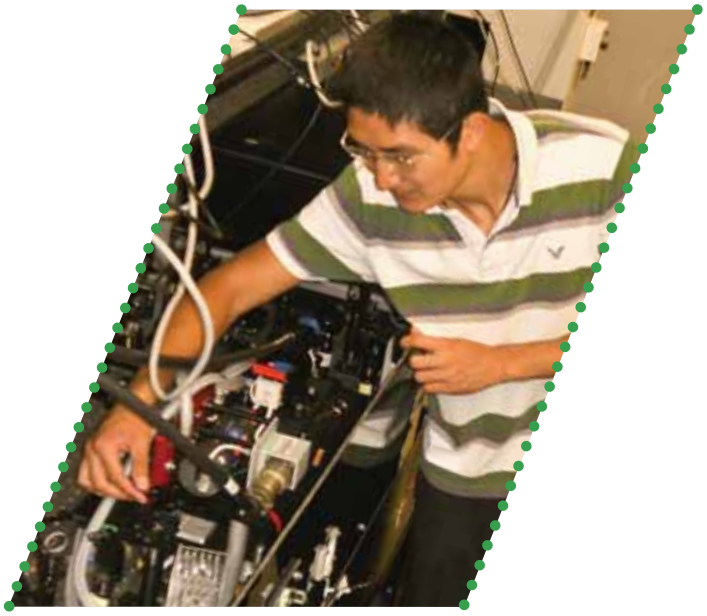
Professor and Area Director
Ph.D., Stanford University, 1998,

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.

- Fellow, IEEE, 2011
- IBM Faculty Development Fellowship, 2003-2005
- Northrup-Grumman Outstanding Teaching Award, 2003



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

Nanostructure Devices and Technology for Nano-architectonics, Nanotheranostics, and Nanoelectronics.

- CAFA Robert T. Poe Faculty Development Award, 2011
- IEEE Electron Devices Society Early Career Award, 2009
- Okawa Foundation Award, 2007

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

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.

- IEEE Fellow, 2008
- DoD NSSEFF Fellow, 2008
- Humboldt Research Award, 2004

Tatsuo Itoh

Distinguished Professor
Northrop Grumman Professor in Microwave Electronics
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 and Area Director
Northrop Grumman Endowed Opto-Electronic Chair in Electrical Engineering
Ph.D., Columbia University, 1989

Silicon Photonics, Biophotonics, Real-time Instruments for biomedical and communication applications.

- R.W. Wood Prize, Optical Society of America, 2008
- Fellow, Optical Society of America, 2004
- Fellow, IEEE, 2003

Chandrashekar Joshi

Distinguished Professor
Ph.D., Hull University, England, 1979

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

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

Jack W. Judy

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.

Kuo-Nan Liou

Distinguished Professor
Ph.D. New York University, 1970

Electromagnetic Scattering by Ice Crystals and Aerosols, Satellite Remote Sensing, Radiative Transfer, and Climate Modeling.

- COSPAR William Nordberg Medal (Application to Space Science), 2010
- Academia Sinica (Chinese Academy of Sciences, Taiwan), 2004
- National Academy of Engineering, 1999

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

Warren Mori

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

Advanced accelerator concepts, advanced light sources, inertial confinement fusion, nonlinear optics of plasmas, plasma physics, and massively parallel computing.

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

Aydogan Ozcan

Associate Professor
Ph.D., Stanford University, 2005

Photonics and its applications to nano and biotechnology.

- NSF CAREER Award 2010
- NIH Director's New Innovator Award, 2009
- IEEE Photonics Society and ONR Young Investigator Awards, 2009

C. Kumar Patel

Distinguished 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 high power laser systems including quantum cascade lasers.

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

Yahya Rahmat-Samii

Distinguished Professor
Northrop Grumman Professor of Electrical Engineering/Electromagnetics
Ph.D., Univ. of Illinois at Urbana-Champaign, 1975

Personal communications, medical, miniaturized, fractal, remote sensing, satellite and radio astronomy antennas; electromagnetic band gap and frequency selective structures, computational and optimization techniques, modern antenna measurement and diagnostic techniques.

- IEEE Electromagnetics Award, 2011
- National Academy of Engineering, 2008
- Fellow, IEEE, 1985

Oscar M. Stafsudd

Professor and Vice Chair
Ph.D., University of California, Los Angeles, 1967

Mid-infrared lasers for applications in materials processing, dentistry, and surgery; ceramic laser media for high power laser systems; Raman imaging and time dependent fluorescent imaging for medical applications (cancer/wounds); infrared detectors.

- Lockheed Martin Excellence in Teaching Award, 2011
- Fulbright Fellowship, 1986

Dwight C. Streit

Distinguished Professor
Ph.D., University of California, Los Angeles, 1986

Solid-state electronics, millimeter-wave devices and circuits, electronic materials, heterogeneous integration.

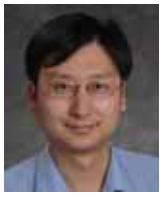
- National Research Council Lifetime Associate, 2008
- Northrop Grumman Distinguished Innovator, 2008
- National Academy of Engineering, 2001

King-Ning Tu

Distinguished Professor
Ph. D., Harvard 1968

VLSI processing and reliability, and 3D IC packaging technology

- Fellow: APS, 1981, TMS, 1988, MRS, 2010
- Humboldt Award,1996



Yuanxun Ethan Wang

Associate 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.

Kang L. Wang

Distinguished Professor
Raytheon Company Professor of Electrical Engineering
Ph.D., Massachusetts Institute of Technology, 1970

Nanoelectronics, spintronics and nanomagnetics; nanoscale science, devices and quantum systems; non-volatile electronics and low dissipation devices; MBE; optoelectronics and solar cells.

- Semiconductor Industry Association Award, 2009
- Semiconductor Research Corporation Technical Excellence Award, 1995
- Fellow, IEEE, 1992

Benjamin Williams

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

Terahertz and mid-infrared lasers and devices; low-dimensional semiconductor nanostructures for opto-electronics; sub-wavelength photonics, plasmonics, and meta-materials.

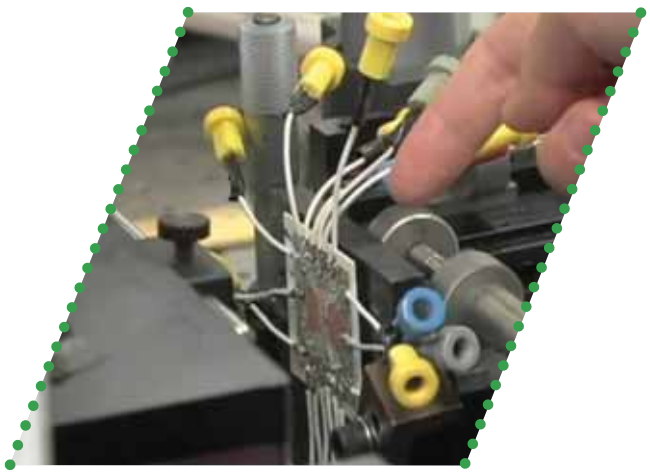
- DARPA Young Faculty Award, 2008

Jason C. S. Woo

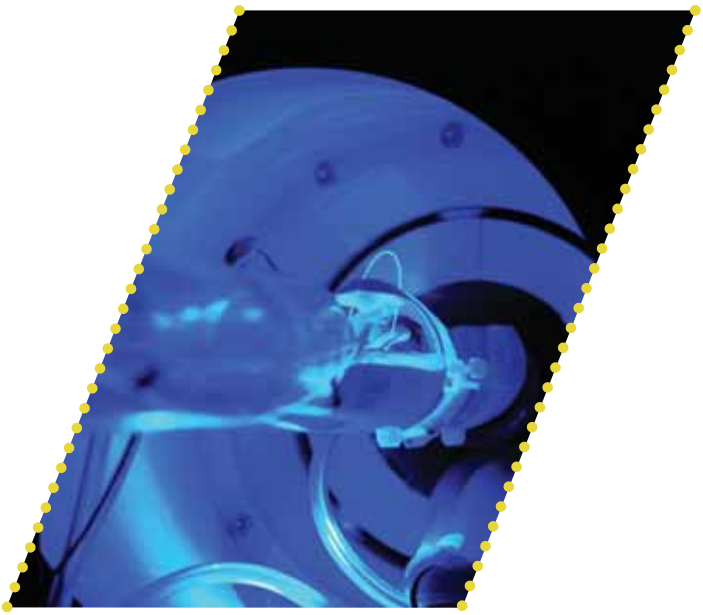
Professor and Vice Chair
Ph.D., Stanford University, 1987

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
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.

- Distinguished Lecturer, ISCA, 2010-2011
- Fellow, IEEE, 2008
- Fellow, Acoustical Society of America, 2003

A. V. Balakrishnan

Distinguished Professor
Ph.D., University of Southern California, 1954

Non-linear aeroelasticity and flutter systems research in green energy and palatal flutter.

- Doctor Honoris Causa, West University of Timisoara, Roumania, 2004
- Richard E. Bellman Control Heritage Award, 2001
- NASA Public Service Medal, 1996

Panagiotis Christofides

Professor
Ph.D., University of Minnesota, 1996

Control theory for nonlinear, hybrid and distributed parameter systems, networked control, model predictive control, fault detection and fault-tolerant control, process control applications

- IFAC Fellow, 2011
- IEEE Fellow, 2009
- Donald P. Eckman Award, 2004

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.

- David J. Sakrison Memorial Prize, UC Berkeley, 2007

Suhas Diggavi

Professor
Ph.D., Stanford University, 1998

Information theory with applications to wireless and sensor networks, network data compression and storage, network secrecy, machine learning and large scale data analysis algorithms.

Mark Hansen

Professor
Ph.D., University of California, Berkeley, 1994

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.

Alan J. Laub

Distinguished 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

Analyze, debug, and engineer the brain circuit, its connectivity and function at the systems level and develop cures for diseases. Biomedical imaging technologies, such as MRI and optical imaging, signal processing algorithms, computational algorithms, optics, genetics, and molecular biology.

- NSF CAREER Award, 2011
- NIH Director's New Innovator Award, 2010
- NIH/NIBIB R00 Award, 2010

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.

- American Academy of Arts and Sciences, 2010
- National Academy of Sciences, 2005

Gregory J. Pottie

Professor and Area Director
Ph.D., McMaster University, Canada, 1988

Wireless communications, modeling and reliable inference in sensor networks with application to wireless health.

- Fulbright Senior Scholar, 2009
- Fellow, IEEE, 2005
- Allied Signal Award for Outstanding Faculty Researcher in HSSEAS, 1998

Izhak Rubin

Distinguished 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

Ali H. Sayed

Professor and former Chair
Ph.D., Stanford University, 1992

Adaptive and statistical signal processing, adaptation and learning, adaptive networks, bio-inspired cognition, distributed processing, information processing, signal processing for communications, system theory, large-scale structured computations.

- Frederick E. Terman Award, 2005
- Kuwait Prize, 2003
- Fellow, IEEE, 2001

Mihaela van der Schaar

Chancellor's Professor
Ph.D., University of Technology, Eindhoven, The Netherlands, 2001

Information processing, Network Economics and Game Theory, Multi-user Communications and Networking, Multimedia Communications, Networking and Processing, Multimedia Systems, Distributed and large-scale stream mining systems

- Fellow, IEEE, 2010
- Editor in Chief, IEEE Trans. on Multimedia, 2011-2013
- NSF CAREER Award 2004

Stefano Soatto

Professor
Ph.D., California Institute of Technology, 1996

Estimation theory, control theory, video, image and signal processing, computer vision, robotics.

- Okawa Foundation, 2001
- David Marr Prize, 1999
- Siemens Prize, 1998

Jason L. Speyer

Distinguished 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, 2005
- Fellow, AIAA, 1985

Paulo Tabuada

Associate Professor and Vice Chair
Ph.D., Technical University of Lisbon, Portugal, 2002

Modeling, analysis, and control of cyber-physical systems. Control and systems theory.

- Donald P. Eckman Award, 2009
- NSF Career Award, 2005

Lieven Vandenberghe

Professor
Ph.D., Katholieke Universiteit Leuven, Belgium, 1992

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

- HSSEAS TRW Excellence in Teaching Award, 2002
- NSF CAREER Award, 1998
- Robert Stock Award, K.U. Leuven, 1993

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.

Richard D. Wesel

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

Communication Theory, Channel Coding including Low-Density Parity-Check Codes and Turbo Codes, Information Theory, Network Optimization

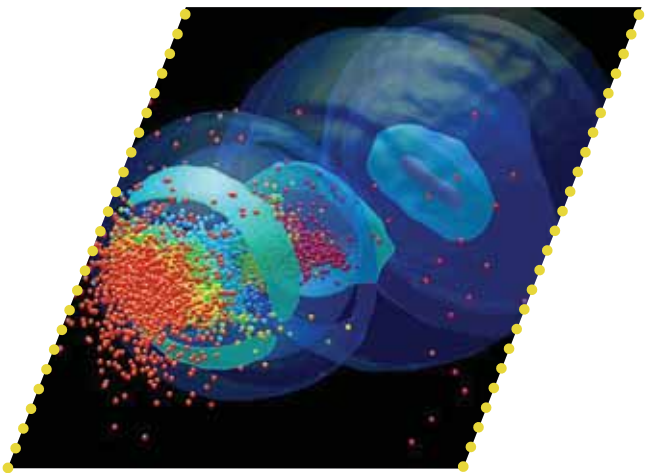
- TRW Excellence in Teaching Award, 2000
- Okawa Foundation Award, 1999
- NSF CAREER Award, 1998

Kung Yao

Distinguished 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.

- IEEE Joint Information Theory/Communication Theory Societies Best Paper Award, 2008
- Life Fellow, IEEE, 1994



Books by Faculty

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

Post-Graduation Academic Placement

Omar Nasr, *2009*

Assistant Professor, Cairo University
Advisor: Babak Daneshrad

Member of the Center for Wireless Studies, currently working in cross layer optimization for multimedia systems over wireless networks.

Gyungsu Byun, *2011*

Assistant Professor, West Virginia University
Advisor: Frank Chang

Research includes high-speed and low-power interface circuits, high performance time-precision circuits. He holds 18 patents in electronic circuits.

Nicholas Mastronarde, *2011*

Assistant Professor, The State University of New York at Buffalo Advisor: Mihaela van der Schaar

Interests in energy-efficient multimedia systems and wireless networks, cross-layer design, Markov decision processes, and reinforcement learning.

Pei-Ling Chi, *2011*

Assistant Professor, National Chaio Tung University, Taiwan Advisor: Tatsuo Itoh

Her research interests include metamaterial-based transmission line theory/circuits and antenna/array designs and miniaturized antennas.

Chiao-En Chen, *2008*

Assistant Professor, National Chung Cheng University, Taiwan Advisor: Kung Yao

His areas of expertise include array signal processing, detection and estimation theories, and MIMO communications.

Wei Lu

Professor in the Department of Engineering Physics, Tsinghua University, Beijing, China
Advisor: Warren Bicknell Mori

Chia-Hsiang Yang, *2010*

Assistant Professor, National Chiao Tung University, Taiwan Advisor: Dejan Markovic

His research interests are energy-efficient reconfigurable architectures and digital integrated circuits for communication and biomedical application.

Wei-Ho Chung, *2009*

Assistant Professor, Academia Sinica, Taiwan
Advisor: Kung Yao

His research interests include detection, estimation, wireless communications, statistical signal processing and networks.

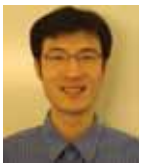
Ping-Hsuan Hsieh, *2009*

Assistant Professor, Electrical Engineering, National Tsing-Hua University. Advisor: C. K. Ken Yang

She joined IBM T. J. Watson Research Center in CMOS circuit and semiconductors, data converters, PLL/DLL, voltage regulators.

Sadaf Zahedi, *2010*

Scholar in Residence, University of Colorado at Boulder
Advisor: Mani Srivastava



Yue Zhao, *2011*

Postdoctoral, Stanford University / Princeton University
Advisor: Greg Pottie

Augustin Hong, *2010*

Postdoctoral Researcher, IBM TJ Watson Research Center
Advisor: Kang Wang

Bibhudatta Sahoo, *2009*

Assistant Professor, Indian Institute of Technology, Kharagpur, India
Advisor: Behzad Razavi

Jaeok Park, *2011 Postdoc*

Assistant Professor, Yonsei University, Korea.
Advisor: Mihaela van der Schaar

Interests includes game theory, mechanism design, network economics, and wireless communication.

Giordano Pola, *2007 Postdoc*

Assistant Professor, University of L'Aquila, Italy.
Advisor: Paulo Tabuada

Research interests include networked, embedded, distributed and hybrid systems, air traffic management systems, quantitative finance and vehicle control.

Sungkyu Seo, *2009 Postdoc*

Assistant Professor, Dept. of Electronics and Information Engineering, Korea University
Advisor: Aydogan Ozcan

Research in Bio Photonics, Nano Electronics, and MEMS/NEMS. Honors include Best Lecture Awards, Korea Univ., UCLA Chancellor's Award for Postdoctoral Research (2009).

Administration

M. C. Frank Chang, *Department Chairman*
Oscar Stafsudd, *Vice-Chair, Undergraduate Affairs*
Paulo Tabuada, *Vice-Chair, Graduate Affairs*
Jason C. S. Woo, *Vice-Chair, Industry Relations*

Area Directors

Gregory J. Pottie, *Director, Signals and Systems*
Bahram Jalali, *Director, Physical and Wave Electronics*
Lei He, *Director, Circuits and Embedded Systems*

ABET Committee

M. C. Frank Chang, *Department Chairman*
Lei He, *Professor and Area Director*
William Kaiser, *Professor*
Alan Laub, *Professor*
Asad Madni, *Alumni Advisory Board Chair*
Gregory J. Pottie, *Professor and Area Chair*
Mani Srivastava, *Professor*
Oscar Stafsudd, *Professor and Area Director*
Lieven Vandenberghe, *Professor*
Jason C. S. Woo, *Professor and Industry Relations*

Committees

Yuanxun Ethan Wang, *Director, Center for High-Frequency Electronics*
Robert Candler, *Director, Nano-Electronics Research Facility*
Babak Daneshrad, *Chair, Tenure Committee*
Behzad Razavi, *Chair, Recruitment Committee*
Lei He, *Chair, Non-Tenure Committee*
Chandrashekar Joshi, *Chair, Courses and Curriculum Committee*

Industry Affiliates

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/people/industry

Our Thanks to Affiliate Members for their Support

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Henry Samueli School of Engineering and Applied Science
Electrical Engineering Department
University of California
Los Angeles, CA 90095
www.ee.ucla.edu

UCLA Engineering
HENRY SAMUELI SCHOOL OF
ENGINEERING AND APPLIED SCIENCE
Birthplace of the Internet

Annual Report 2010-2011

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Jacquelyn T. Trang, *Department Administrator*

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Professor Diana Huffaker
Professor Bahram Jalali
Professor Chandrashekar Joshi
Professor Warren Mori
Professor William Kaiser
Professor Kang Wang
Professor Chih-Kong Ken Yang
Assistant Professor Lara Dolecek
Assistant Professor Puneet Gupta
Professor Mani B. Srivastava
Professor Mihaela van der Schaar
Professor Kung Yao
Professor Izhak Rubin
Professor Behzad Razavi
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