Department of Electrical & Computer Engineering

Industrial Affiliates Newsletter

April 2008

Department of Electrical and Computer Engineering: Quick Overview

The Department of Electrical and Computer Engineering at UC Davis has a long-standing tradition of continuing enhancement to undergraduate and graduate education and high quality research from its faculty. We are one of the largest departments in the College with 30+ ladder-rank faculty, 15 emeritus professors, and several adjunct and research faculty, post-docs and visiting scholars.

We serve about 500 undergraduate and 200 graduate students, meeting the needs of a diverse constituency. Our mission, research and educational objectives, and program objectives stem directly from the land grant origins of the University of California and our constituent's needs.

Our research activities are broadly divided into seven major areas of electrical and computer engineering. Specifically, our faculty actively conduct research in Communication, Signal & Image Processing; Computer Engineering; Electronic Circuits; Optoelectronics; RF, Micro- & Millimeter Waves; Solid State Electronic Devices and Systems & Control.

Our faculty's research and teaching activities receive constant recognition from professional communities and sponsoring agencies.

The level of extramural funding for research activities of the faculty is continuing to grow and it is over $5 million in the last year.

The department faculty have been very active in defining and developing new interdisciplinary research and collaborative efforts. The department has also been effective in recruiting and

training top graduate students in its multi-disciplinary environment.

In addition to graduate student education and research, our undergraduate programs provide a rigorous foundation, and enhance the undergraduate experience through exposure to a strong research environment.

New Department Chair Welcomed

Richard A. Kiehl joined the University of California, Davis as professor of Electrical and Computer Engineering in January 2008. He was professor of Electrical and Computer Engineering at the University of Minnesota from 1999 to 2008 and acting professor of Electrical Engineering at Stanford University from 1996 to 1999. From 1992 to 1995 he was assistant director of the Quantum Electron Device Laboratory at Fujitsu Laboratories Ltd, Japan. Prior to that he was a member of technical staff at the IBM T. J. Watson Research Center (1985-1992), AT&T Bell Laboratories, Murray Hill (1980-1985), and Sandia National Laboratories (1974-1980). He received the Ph. D. degree from the School of Electrical Engineering, Purdue University.

In this issue:

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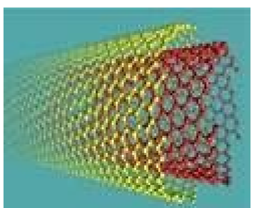
Richard A. Kiehl
Professor & Chair of ECE

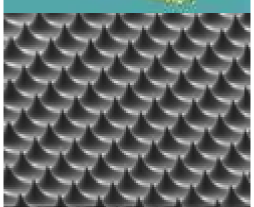
With 30+ ladder rank, 15 emeriti, and several adjunct and research faculty members, the ECE dept is home to numerous exciting research projects.

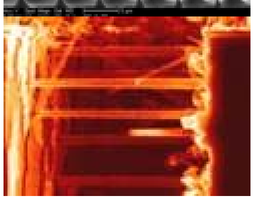
Communication, Signal and Image Processing

The Communication, Signal and Image Processing group focuses on research projects ranging from mathematical foundations to applications of signal processing in wireless communication, image processing, coding, storage systems, genomics, networking and several other application domains.

Present research projects focus on novel wireless digital communication system design and implementations, MIMO wireless transceiver optimization and crosslayer integration, space-time coded modulation and channel estimation, wireless LAN and WiMAX, new methods for hybrid ARQ equalization and decoding, higher order statistical signal processing, channel estimation and channel equalization, ultra-wideband (UWB) local area networks, cyclo-stationary signal processing, adaptive and array signal processing, image processing and coding based on image analysis and on properties of human perception, 3D sound perception modeling and simulation, customized 3D spatial hearing modeling and approximation for high-quality spatial sound simulation, event detection in seismic signals and target cueing in hyperspectral images.







Computer Engineering

The Computer Engineering group encompasses the research efforts of ten faculty members and their students. Research projects span over a wide range of topics ranging from high-level design specification and compilation to digital circuit design and optimization.

Currently, the following research topics are actively pursued in the computer engineering group: architecture, implementation and compilation for chip multiprocessors, embedded system for multi-media applications, distributed and collaborative embedded systems, energy-aware compilation, computer-aided design, verification and testing of digital systems, fault-tolerant computing and reliable data compression, life-time validation of digital systems, optimal instruction scheduling and register allocation in compilers, robust, stable and efficient management of network control plane, network measurement and monitoring, graphics and graphics architecture, and sensor networks.

Solid State Electronic Devices and Sensors

The Solid-State group focuses on research projects involving fabrication of electronic materials and devices as well as non-electronic micro and nanostructures.

Research projects include investigation of kinetic phenomena during epitaxial growth of Si-Ge-C films; synthesis and device integration of semiconductor nano-structures; development of novel characterization techniques for quantum structures; nano-structured sensors; semiconductor wafer bonding and low-temperature wafer bonding of silicon and compound semiconductors; etch-stop development; field-emission vacuum microelectronics for flat-panel display and microwave amplifier application; micro-sensor packaging; microjoints for 3-D assembly; high-temperature electronic materials research; semiconductor opto-electronics and optical excitation of field emitter arrays; microfabricated bio and chemical analysis instruments; Silicon-on-Insulator (SOI) device physics and processing.

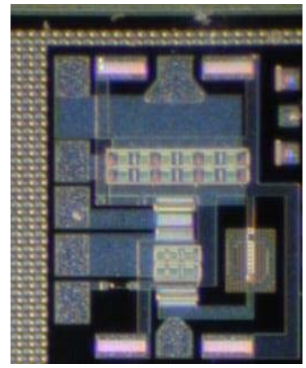
Department research activities are broadly divided into seven major areas of electrical and computer engineering.

Electronic Circuits

This group's interests are in analog and digital circuit design, specifically focusing on designs for integrated circuits in CMOS technologies. The goal of the research is to develop new circuit architectures and techniques that advance the state of the art in specific areas, including the following: analog or mixed analog/digital implementations of advanced signal processing algorithms for digital magnetic recording, digital communications, including adaptive equalizers, Viterbi detectors, timing recovery circuits; analog-to-digital converters and their calibration; mismatch insensitive double-sampled delta-sigma modulators; low voltage circuits for data communications and conversion; circuitry for integrated sensors; development of CAD software for IC design; and design of multi-valued logic.

RF, Micro and Millimeter Waves

The research of this group focuses on the efficient generation and transfer detection of electromagnetic energy in the frequency ranges from approximately 100 MHz to greater than 100 GHz. Topics of research include the design and development of radio frequency integrated circuits using Si CMOS for communications applications. Passive devices including the design of reduced-size microstrip coupling devices using left-handed propagation concepts, filters, planar power divider circuits, and broadband hybrid couplers, and antennas in multi-layer organic boards; nonlinear microwave device research with extensive activity being directed toward active RF/microwave power amplifiers, multipliers (1-30 GHz range), quasi-optical grid arrays and solid state devices to serve as high power millimeter wave oscillators, amplifiers, frequency multipliers, beam controllers and mixers; generation of picosecond signals using monolithically fabricated nonlinear transmission lines; research centering on the automatic phase noise measurement system, which permits the analysis and modeling of the phase noise characteristics of oscillators, phase-locked loops and amplifiers used in wireless communication systems; photonic control of phase array antennas; high-frequency characterization methods for low-dielectric constant thin films and biosensors; development of hermetic multi-layer organic packages and multi-chip modules using liquid crystal polymer; development of RF/wireless sensors for bio- and chemical detection.



Optoeletronics

The Optoelectronics Group performs research on devices and systems for optical communication, instrumentation and fundamental science. The objective is to develop new materials, devices, and system-concepts that will advance optical technology, metrology and science.

At present, the group is comprised of five faculty members with diverse research activities. In optical fiber telecommunications we have design and modeling of transparent optical networks, research on space-switching and wavelength conversion techniques for Next Generation Network applications, arbitrary optical waveform generation and design and fabrication of micromachined optical systems. In the area of nonlinear optics and frequency conversion, we are developing organic polymeric films with large electro-optic effects and incorporating them into devices used for high-bandwidth modulation, second-harmonic generation, photonic integrated circuits, and phased-array antennas. Nonlinear optical spectroscopy and imaging are also used to investigate the molecular structure in biomolecules and the self-organization of such molecules to provide biological function. In the area of vacuum microelectronics we are investigating optical gating of field emission from microstip arrays for advanced microwave tube applications. Ultrafast lasers capable of producing <20 femtosecond pulses are being studied as sources of very stable microwave and millimeter-waves and even as clocks. The stability of laser clocks has recently surpassed that of atomic frequency standards and we are investigating fundamental limits on laser clock performance. We are also exploiting the tremendous peak power of femtosecond lasers to create monocycle THz pulses for studies of plasmas and basic materials science. Finally, we are using tabletop terawatt femtosecond laser pules to generate tunable, monochromatic, high-brightness x-rays by Compton scattering for medical diagnostics, imaging and healthcare.

The optoelectronics research facilities consists of seven laboratories equipped with state-of-the-art lasers and high-speed instrumentation for optical and electronic characterization. Fabrication of photonic integrated circuits and micromachined optical systems takes place in the ECE Microfabrication Facility. The opto-electronic group collaborates with researchers at several academic and industrial institutions, including UC Berkeley, Stanford University, Lawrence Livermore National Laboratory and IBM Almaden Research.

Currently, the dept serves about 500 undergraduate and 200 graduate students. About two thirds of graduate students pursue the Ph.D. degree.

Systems and Control

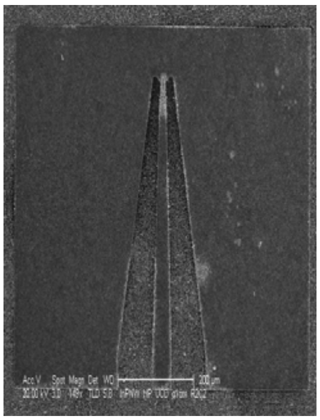
This group focuses its research on control of constrained linear and nonlinear systems. The major research activities include nonlinear system theory, robust and reliable systems, adaptive control, intelligent control, neural systems, optimization-based design and control and rapid thermal process control.

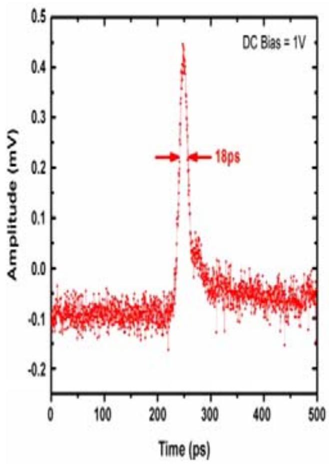
In the systems and control area research is performed on theoretical and/or design-oriented topics in the following areas: nonlinear systems and control theory, multi-input multi-output feedback systems, decentralized control, robust control, reliable control, adaptive control, and optimization-based design of nonlinear control systems;

Current activities in the decision and control area include decision support and scheduling for IC manufacturing, VLSI physical design automation, global and local optimization with applications, neural networks, and control system design.

Selected Research Activities

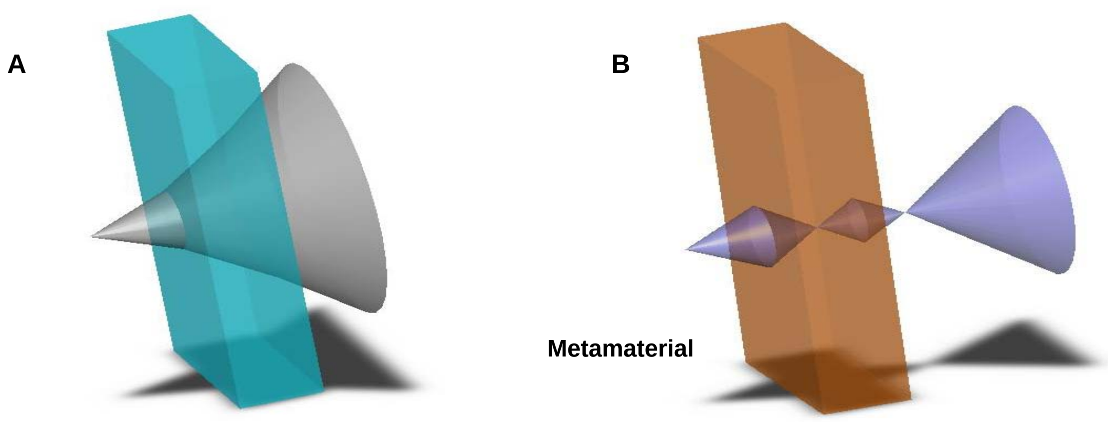
The Fastest Nanowire Photoconductor on Amorphous Surface





Researchers from the Integrated Nanodevices and System group (Inano) of the ECE department have reported the ***fastest nanowire based polarization-insensitive photoconductor*** with temporal response ***18-ps*** grown on amorphous surface. A very low noise, low capacitance, small physical size, and demonstrated ability to assimilate with mainstream silicon electronics in large numbers are some of the desired features for the published photodetector that will serve the requirements for future chip-to-chip and on-chip interconnects. The results were reported in *Applied Physics A, Vol.91, pp.1-5 (2008)* and also won the best post deadline paper award in *IEEE LEOS 2007*. The research was done in collaboration with University of California-Santa Cruz, NASA Ames Research Center & Quantum Science Research, Advanced Studies, Hewlett-Packard Laboratories, Palo Alto. UC Davis Student Researcher: Logeeswaran Veerayah Jayaraman

Tunable Integrated Photomodulated Metamaterial Realized!



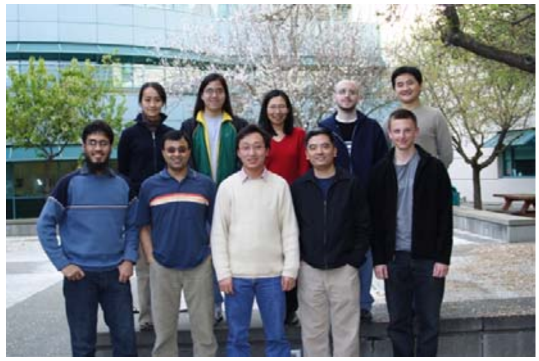
(A) Regular positive index slab materials cause light divergence while **(B)** negative index slab metamaterials focus the light. We can use this phenomenon to modulate light in the materials.

Researchers from the Integrated Nanodevices and System group (Inano) of the ECE department have demonstrated novel a technique for modulating the index of negative index materials (NIM) via photoconductive coupling. This demonstration may provide a basis for long-sought practical applications and devices based on NIM in the fields of ultra-fast communications at RF and optical frequencies, sensing and imaging promising a potential of dramatically improving the performance of existing phased array antennas, optical beam-forming networks, antenna remoting and transportation of RF power through fiber-radio. The research was done in collaboration with University of California-Davis & Quantum Science Research, Advanced Studies, Hewlett-Packard Laboratories, Palo Alto. The work has been reported in *Applied Physics A, Vol.87, pp.209-216 (2007) and Proc. SPIE 6772, 677208 (2007).* UC Davis Student Researcher: Logeeswaran Veerayah Jayaraman

Robust & Ubiquitous Networking (RUBINET) Research Group

http://www.ece.ucdavis.edu/rubinet/

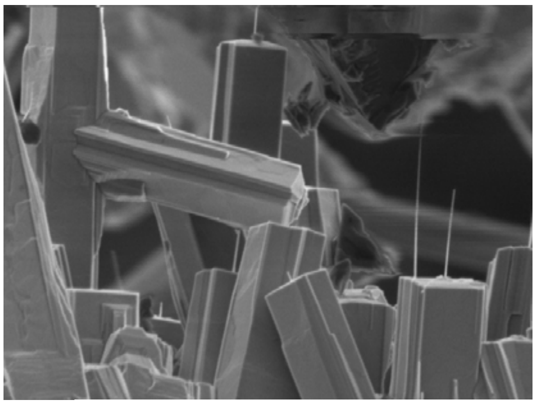
Led by Prof. Chen-Nee Chuah, the RUBINET research group focuses on designing new infrastructures, protocols, and techniques that improve robustness, availability, security, and efficiency of networking systems. We also strive to develop foundations for measuring modeling, and validating large-scale networks for a variety of critical network design and security applications. Recently, we launch a new effort to pursue a "clean-slate" design of the future Internet measurement architecture with not only built-in hardware and software primitives incorporated into network elements, but also network-wide architectural support for traffic measurement and analysis. This measurement substrate must be adaptive, versatile, programmable, modular, and scalable to high link speeds in order to meet the complex, diverse, and fluid needs of future network services and applications–many of which are yet to be imagined. RUBINET currently consists of 10 PhD students and 2 MS students. The projects are funded by National Science Foundation grants, UC Micro Programs, gifts from industrial sponsors (Hewlett Packard, Intel, Narus, and Sprint).

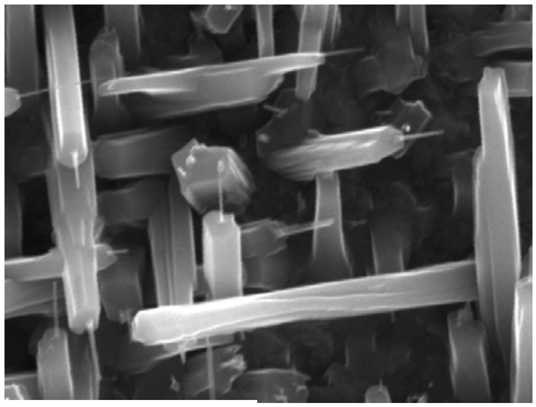


Recent Highlights:

Chuah received a new National Science Foundation (NSF) CyberTrust grant in 2007 for her work on "Accurate Sampling of the Internet for Effective Anomaly Detection". This is a three-year collaborative project with Prof. Jun Xu at the Georgia Institute of Technology. Research under the new grant will explore advanced sampling techniques that can obtain accurate traffic statistics for effective anomaly detection, which is a critical component of first-line network defense systems.

World's Best Metal-Oxide Field Emitter





SEM images of Ga_2O_3 Nanorods and Ultra-Sharp tips

Researchers from the Integrated Nanodevices and System group (Inano) of the ECE department have successfully synthesized Ga_2O_3 nanorods with the sharpest tips reported to date. These nano structures turn out to be known best metal-oxide field emitter ever. The field emission characteristics of the nanostructures were measured to be as good as Carbon materials such as nanostructured diamond and various highly-oriented single-wall carbon nanotubes, known as the best field emission materials. The results were submitted to IEEE Nano 2008 8th International Conference on Nanotechnology. The field emission study was done in collaboration with Vacuum Micro Electronics Group from UC Davis Department of Electrical and Computer Engineering. UC Davis Student Researcher: Yavuz Bayam

Recent Accomplishments

Professor Anh-Vu Pham Chosen for 2008 IEEE MTT-S Outstanding Young Engineer Award

Professor Anh-Vu Pham has been named as the recipient of the Institute of Electrical and Electronics Engineers (IEEE) Microwave Theory and Techniques Society (MTT-S) Outstanding Young Engineer Award. Prof. Pham is being recognized for his contributions to the development of microwave and millimeter wave organic packages, components, and multi-chip modules. He will receive this award at the annual IEEE MTT-S International Microwave Symposium, to be held in June 2008 in Atlanta, Georgia.

Professor S. J. Ben Yoo is Elected a Fellow of IEEE, and is also Elected a Fellow of OSA

Professor S. J. Ben Yoo was elected a Fellow of the IEEE, effective January 1, 2007, and was also elected a Fellow of the Optical Society of America. Prof. Yoo's main area of expertise and interest is photonic systems and technologies for next generation networks. His work has demonstrated a new class of wavelength converters for transparent optical networks, optical label switching routers and integrated photonic systems-on-a chip. The citation reads "For contributions to optical networking and technologies, in particular, wavelength conversion, optical label switching networks, optical routers, and integrated photonics."

R.W. Wood Prize goes to Professor Jonathan Heritage

Prof. Jonathan Heritage of UC Davis, together with his colleague at Purdue University, Prof. Andrew M. Weiner won one of the most distinguished awards in optics, the R. W. Wood Prize.
Established by OSA in 1975 to honor the many contributions that R.W. Wood made to optics, this award recognizes an outstanding discovery, scientific or technical achievement, or invention in the field of optics. The accomplishment for which the prize is given is measured chiefly by its impact on the field therefore the contribution is one that opens a new era of research or significantly expands an established one.
It is endowed by the Xerox Corporation.

Lisa Poyneer Receives Anil Jain Memorial Prize

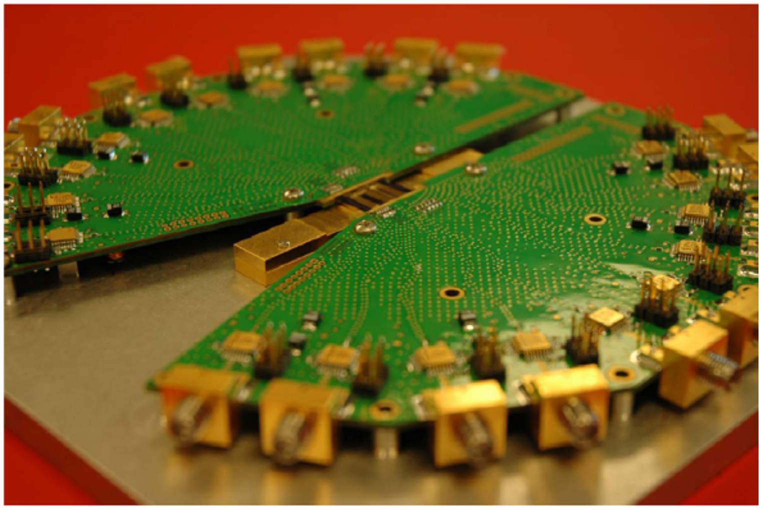
Lisa Poyneer, a recent Ph.D. graduate, has been selected as winner of this years Anil Jain Memorial Prize for best Ph.D. Dissertation. Lisa completed her PhD dissertation under Dr. Bernard Levy and her main scientific mentor was Dr. Bruce Macintosh, the leader of the Gemini Planet Imager project at LLNL. She came to UC Davis in the Fall of 2003 and graduated in June 2007.
Her dissertation, entitled "Signal processing for high precision wavefront control in adaptive optics," was selected by the ECE Awards Committee as the best Ph.D. Dissertation from 2006-2007.
The Anil Jain Memorial Prize was established in 1990 in honor of the late Professor Anil Jain (ECE). The Prize is awarded annually to the best PhD student dissertation in the department of ECE. The winner receives a $1000 check and a certificate.
Dr. Poyneer currently works as a staff member at the Lawrence Livermore National Laboratory.

Phase II for Ultrafast Optical Communications

The Defense Advanced Research Projects Agency (DARPA) has approved the second phase of a $10.7 million project over four years to UC Davis, MIT and commercial partners to develop new high-speed devices for ultra fast optical communications, imaging and other applications. This successful Phase I to Phase II transition provides UC Davis an additional $4,204,716 over the two years to pursue innovative optical communication technologies on an integrated semiconductor chip.

"We will be prototyping a compact, optical arbitrary waveform generator capable of communicating at unprecedented bandwidth, potentially 10 thousand times faster than the fastest commercial communications system today," said co-principal investigator S. J. Ben Yoo, professor of electrical and computer engineering and director of the UC Davis Center for Information Technology Research in the Interests of Society. Optical and radio communications devices generate a carrier wave of a specific frequency, for example the transmission frequency of a radio station. The amount of information, or bandwidth, carried by the wave can only be a fraction of that frequency. Optical communications links can carry far more information than radio because light waves have a much higher frequency than radio waves.

The DARPA project aims to investigate how to use and manipulate the high carrier frequencies of mid-infrared light most effectively. Prof. Yoo's research group will use technology invented at UC Davis to design, build and test the thumbnail-sized chips. The MIT group, led by Professor Erich Ippen, will build devices to generate the high-frequency carrier wave. Apart from high-speed communications, the technology could also be applied to light-based radar devices or "ladar," capable of very high resolution scanning; medical imaging; or in devices of synthesizing very rich electronic tones, Prof. Yoo said. The other UC Davis investigators in the project are Jonathan Heritage, and Anh-Vu Pham, both professors in the Department of Electrical and Computer Engineering. The commercial partners are Inphi Inc. of Westlake Village, Calif., and Multiplex Inc. and Inplane Photonics Inc., both of South Plainfield, N.J.



Optical chip with high-speed driving electronics interface for the Phase I 100 Gb/s system module. Phase II system targets 1 Tb/s.
Additional information: Next Generation Networking Systems Laboratory: http://sierra.ece.ucdavis.edu/

UC Davis teams with BBN Technologies

Prof. S. J. Ben Yoo's team at UCDavis, with BBN Technologies; RTI International; RENCI; Verizon Federal Network Systems; Photon Futures, LLC; Optoelectronic Consulting, LLC; and LabN have been awarded $5.7 million in funding by the Defense Advanced Research Projects Agency (DARPA) for the Dynamic Multi-Terabit Core Optical Networks: Architecture, Protocols, Control and Management (CORONET) program. BBN will lead the team. The objective of the CORONET program is to revolutionize the operation, performance, survivability, and security of the United States' global IP-based inter-networking infrastructure through improved network architecture, protocols, and control and management software. As envisioned, the target CORONET optical network will enable ultra-fast service set-up/tear-down and very fast and efficient recovery from multiple network failures. An important goal of the program is to transition the CORONET technology to commercial telecommunications carriers, as well as to Department of Defense and other US government global networks.

CORONET technology will facilitate more rapid configuration of network resources to better react to the dynamically changing global military and commercial communications needs, as well as to events such as localized surges in capacity requirements that result from natural disasters. Furthermore, the significant increase in network capacity that is a key component of the CORONET program is needed to support bandwidth-intensive, network-centric collaborative and distributed computing applications, and to accommodate the continued growth of video services.

During the 20-months of Phase I of the CORONET program, UC Davis will architect the next generation optical systems, develop very rapid control planes, and simulate the next generation optical core networks.

More from BBN Technologies website: http://www.bbn.com/news_and_events/press_releases/2008_press_releases/pr_31808_coronet

Student News from the Department

Student Paper Award

Murat Demirkan, Stephen Bruss and Professor Richard Spencer won the 2nd-place Student Paper Award at the 2007 Radio-Frequency Integrated Circuit (RFIC) Symposium for their paper entitled "11.8GHz CMOS VCO With 62% Tuning Range Using Switched Coupled Inductors"

Stephen O. Rice Award

Professors Shu Lin and Khaled A.S. Abdel-Ghaffar along with their former PhD students Ying Yu Tai, Lan Lan, and Lingqi Zeng have won the Stephen O. Rice Award from the IEEE Communications Society for their paper titled, Algebraic Construction of Quasi-Cyclic LDPC Codes for the AWGN and Erasure Channels. This award is for the best paper in communications theory published by the IEEE Communications Society in any given year.

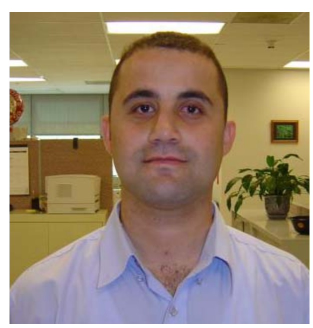
NATCAR 2007—UCD team wins competition

With an average speed of 7.57 ft/sec, racers Kayvan Abbassian and Bill Wang (Team UCD3) took first place at the NATCAR 2007 Race.

ECE Ph.D. Student, Marwan Batayneh wins Best Paper Award

ECE Ph.D. Student, Marwan Batayneh won the Best Paper Award for the Optical Networking Symposium at IEEE Globecom 2007 Conference (held in Washington DC in Nov. 2007).

Networks Lab PhD student Marwan Batayneh, his research advisor Professor Biswanath Mukherjee, and their research collaborators Dr. Andreas Kirstädter, Dr. Dominic A. Schupke, and Dr. Marco Hoffman from Siemens, Germany, have won the Best Paper Award for their paper "Lightpath-Level Protection versus Connection-Level Protection for Carrier-Grade Ethernet in a Mixed-Line-Rate Telecom Network" in the Optical Networking Symposium at the annual IEEE Globecom 2007 Conference.




Nick Fontaine, ECE GSA President

ECE Graduate Student Association: An Update

The ECE GSA is actively involved in many social, academic, and philanthropic activities. This year they put on a canned food drive during the holiday season, started journal clubs for students and faculty, assisted first year students with preparing for preliminary exams, helped recruit students from all across the country during our annual recruitment weekend, created a department t-shirt as a fundraiser, sponsored a pumpkin carving contest, weekend retreat at Yosemite, trip to computer museum in San Jose and had some fun along the way. Led by ECE GSA President Nick Fontaine, and other graduate students—Alex McCourt, Frank Maker, Mat Temmerman, DAvid Geisler, Ryan Scott, Maggie Zhang, David Stoops, Theresa Mulder, Huan Liao, as well as Graduate Coordinator Kate Shasky.

Computing of the Future

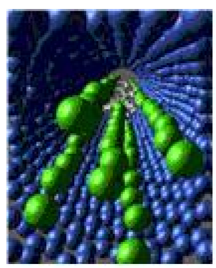
What will computing be like in 20 years? What is the future beyond the end of the current roadmap for CMOS microprocessors?

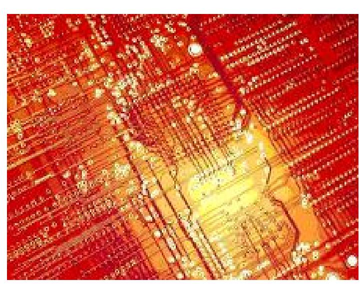
UC Davis CITRIS hosted a workshop addressing the key issues in computing on February 29, 2008, at Crowne Plaza Hotel in San Francisco Airport. This invitation only event was attended by 70 key members from industry, government, and academia.

The phenomenal advances in computing technology over the past two decades were enabled by Dennard scaling, whereby the exponential improvements in power efficiency and performance and cost-effectiveness of silicon technology tracked Moore's Law improvements in integrating more devices on each chip. As we approach atomic scale lithography, the end of Dennard scaling puts future growth of the computing industry in jeopardy. Multicore has provided a temporary respite from stagnation of CPU clock frequencies, but creates daunting challenges to programmability, and drives today's system architectures towards extreme levels of unbalanced communication-to-computation ratios!

This workshop promoted discussions on a comprehensive strategy that directly addresses the challenges of power-density, bandwidth limits, programmability, and interconnect technologies. One of the central goals of the workshop was to discuss methods to eliminate the growing system imbalance performance gap by creating a new computing platform where bandwidth is uniformly plentiful across the entire system and is not traded off the power budget. A system with such uniform system-wide bandwidth offers significantly simpler optimization strategies for software architects that address many of the programmability concerns for multicore chips and massively parallel computing platforms. Addressing the three key areas of energy consumption, bandwidth scaling, and programmability will enable continued exponential improvements in power-efficiency, performance, and cost-effectiveness that drive the computing industry for the next 20 years. This workshop addressed key opportunities and challenges of Future Computing, in the architecture, nanotechnologies, interconnection, and systems areas.

http://www.cevs.ucdavis.edu/cofred/public/Aca/WebSec.cfm?confid=346&webid=1765





Excellence in Education Award

Professor Richard Spencer has received the ASUCD 2007 Excellence in Education Award for the College of Engineering. This was the fifth annual set of ASUCD excellence in education awards. Each year, seven awards are given with one in each of six colleges or divisions and one overall award winner selected from the six winners.


Professor Richard Spencer

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