THE ECE CURRENT

Fall 2014

NADIR DAGLI
Lower Power Photonics

JOSE HERNÁNDEZ
Q&A with ECE's Astronaut

CHAIR'S LETTER

These are exciting times for ECE. We have just concluded a very successful faculty hiring cycle that brought to our campus two top researchers, Professor Yuan Xie and Assistant Professor Alberto Busetto. I encourage you to become familiar with Yuan and Alberto through the short articles included here and through their websites. In addition to these two hires, we have several faculty searches at different stages of the process. This aggressive hiring policy is enabling us to overcome the challenges arising from recent and pending retirements. It is also allowing us to create new areas of strength for the Department that are aligned with current scientific and technological trends.

This issue of "The ECE Current" contains several articles devoted to our greatest accomplishments: our students. Reflecting on our past, you can read about the career and accomplishments of one of our preeminent alumni, Jose Hernández. We include here an excerpt of a long interview that Jose gave to UCSB, but we encourage you to watch the full interview on our website. We also feature our graduating seniors in an article about their capstone projects and their successes in launching new businesses. Lastly, in our student spotlight, you can read about our efforts to attract minority and underprivileged students to UCSB, in particular to the sciences and engineering.

I want to conclude this letter with a word of thanks to our donors. Every year UCSB receives donations to support the ECE Department. While the donors generally give us great freedom on how to use these funds, our goal is to use them towards strategic improvements, such as bringing new equipment to our teaching labs or to improve some of our education spaces. I know that many of you reading this newsletter are long time contributors to the Department, so I encourage you to continue to support us and also to let us know if there are particular areas you would like your gifts to support.

João Pedro Hespanha

NEW FACULTY

Yuan Xie

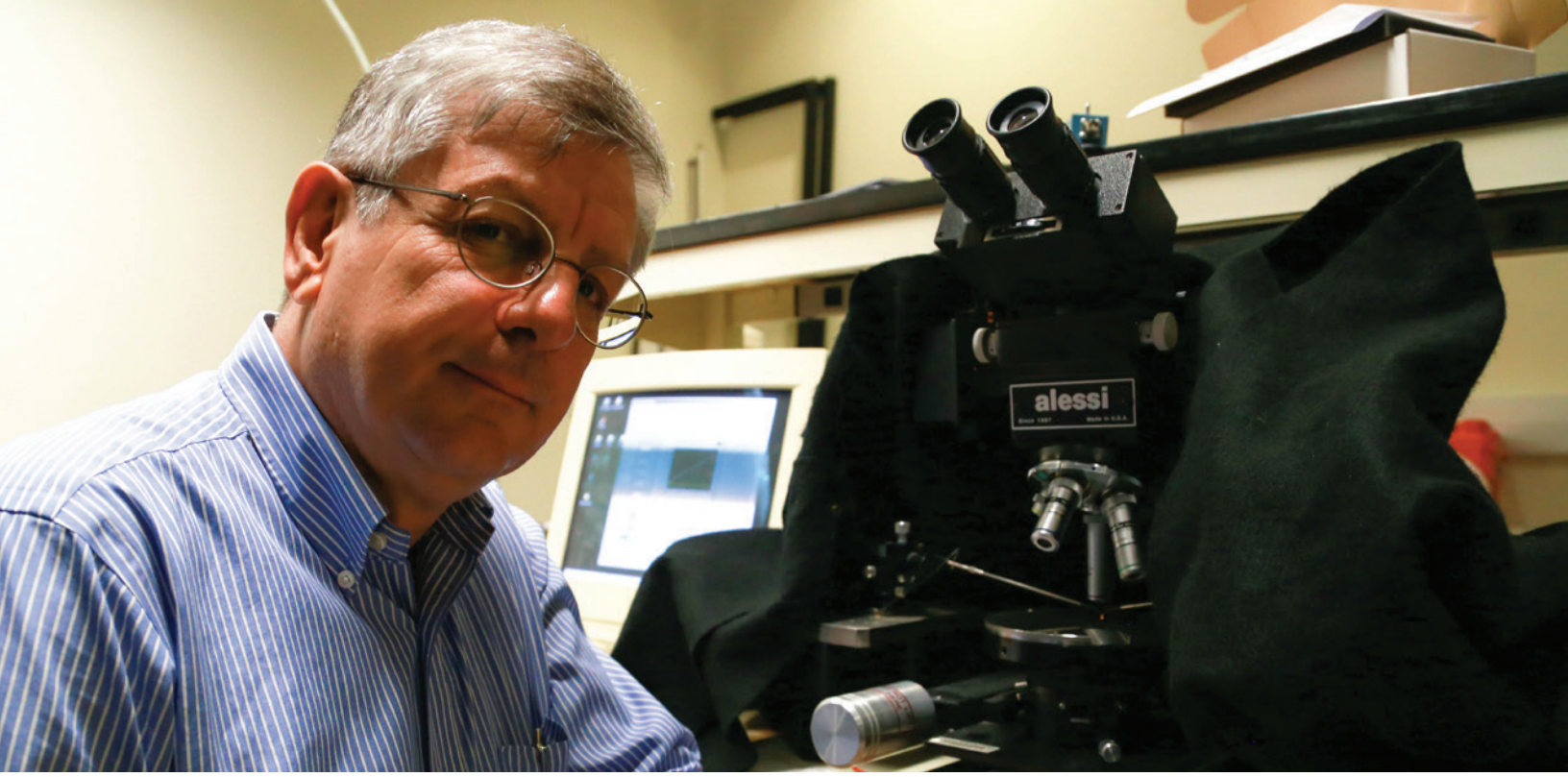
Yuan Xie joined the ECE Department as a Professor in Fall 2014. He received a B.S. degree from Tsinghua University, and M.S. and Ph.D. degrees from Princeton University. Before joining UCSB, he was a faculty member at Penn State since 2003. He was an advisory engineer at IBM Microelectronic during 2002-2003, and led AMD research lab in China during 2012-2013. His research includes: three-dimensional integrated circuits (3D ICs) design, EDA, and architecture; emerging memory technologies; low power and thermal-aware design; reliable circuits and architectures; and embedded system synthesis.

Professor Xie has received the National Science Foundation Early Faculty (CAREER) award, the SRC Inventor Recognition Award, IBM Faculty Award, and several Best Paper Awards and Nominations at IEEE/ACM conferences. He served as TPC chair for MPSOC 2011, ASPDAC 2013, and ISLPED 2013. He is currently Associate Editor for ACM Journal of Emerging Technologies in Computing Systems (JETC), IEEE Transactions on Very Large Scale Integration Systems (TVLSI), ACM Transactions on Design Automation for Embedded Systems (TODAES), and IET Computers and Digital Techniques (IET CDT).

Alberto Giovanni Busetto

Alberto Giovanni Busetto joined the ECE Department as an Assistant Professor in Fall 2014. In 2013, he completed his doctoral studies in machine learning and computational systems biology at ETH Zurich, Switzerland. He received the ETH Medal for Outstanding Doctoral Thesis for his research in measuring and optimizing the value of information for dynamical systems. He has been awarded the Best Student Paper at the International Conference in Artificial Intelligence in Education, as well as the Best of Intelligent Tutoring Systems 2012 IJAIED Series for designing predictive computer systems for intelligent human tutoring, and the Best Paper Award at the IEEE International Conference in Computational Science and Engineering for predictive modeling of molecular signaling processes.

He is establishing an interdisciplinary research program to generate useful knowledge from raw data. Conceptually, the research goal is to select useful bits of information from available data to solve a specific optimization task. He focuses on the design of new methods for active and reinforcement learning of complex processes to build predictive systems for computing, control, and signal processing.



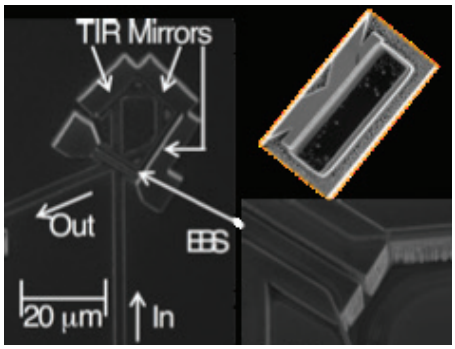
RESEARCH INITIATIVES

Lower power photonics

Widespread use of the Internet due to many rapidly emerging applications necessitates the transport of massive amounts of data on demand. Internet traffic is now quantified in petabytes and exabytes rather than terabytes. Internet traffic in North America is expected to hit 100 exabytes by 2016. The only technology that can deliver such transport is fiber optics. One of the biggest challenges for this technology is rapidly growing power consumption. For example, data centers that store and deliver data on the Internet consume about 5% of total power consumption in the US. These data centers are located in areas with abundant water or even in arctic areas to facilitate the cooling needed. Hence there is a pressing need for low power fiber optic components. Such work is ongoing in Professor Nadir Dagli's laboratory. Specific examples are:

Very low drive voltage and very wide bandwidth electro-optic modulators

The optical modulator is a key component for fiber optics. It imparts electrical data to the output of a semiconductor laser, which is transmitted through the optical fiber. Today's modulators require drive voltages of 3 to 5 V to turn on and off. Since the electronic chip output is typically limited to less than 1 V a modulator driver is needed to drive the modulator. Dr. Dagli's group demonstrated electro-optic modulators with 0.3 V drive voltage using bulk GaAs/AlGaAs with 7 mm long electrodes. For example, reducing the drive voltage from 3 V to 0.3 V reduces power consumption of the modulator 100 times. Combined with further power savings due to the elimination of the modulator driver provides a very significant power reduction. The power needed to drive one existing modulator can drive hundreds of low power modulators. Recently drive voltage was further reduced to 0.2 V and device electrode length to 3 mm using InP based epitaxial layers containing multiple quantum wells. This corresponds to 0.06 V-cm

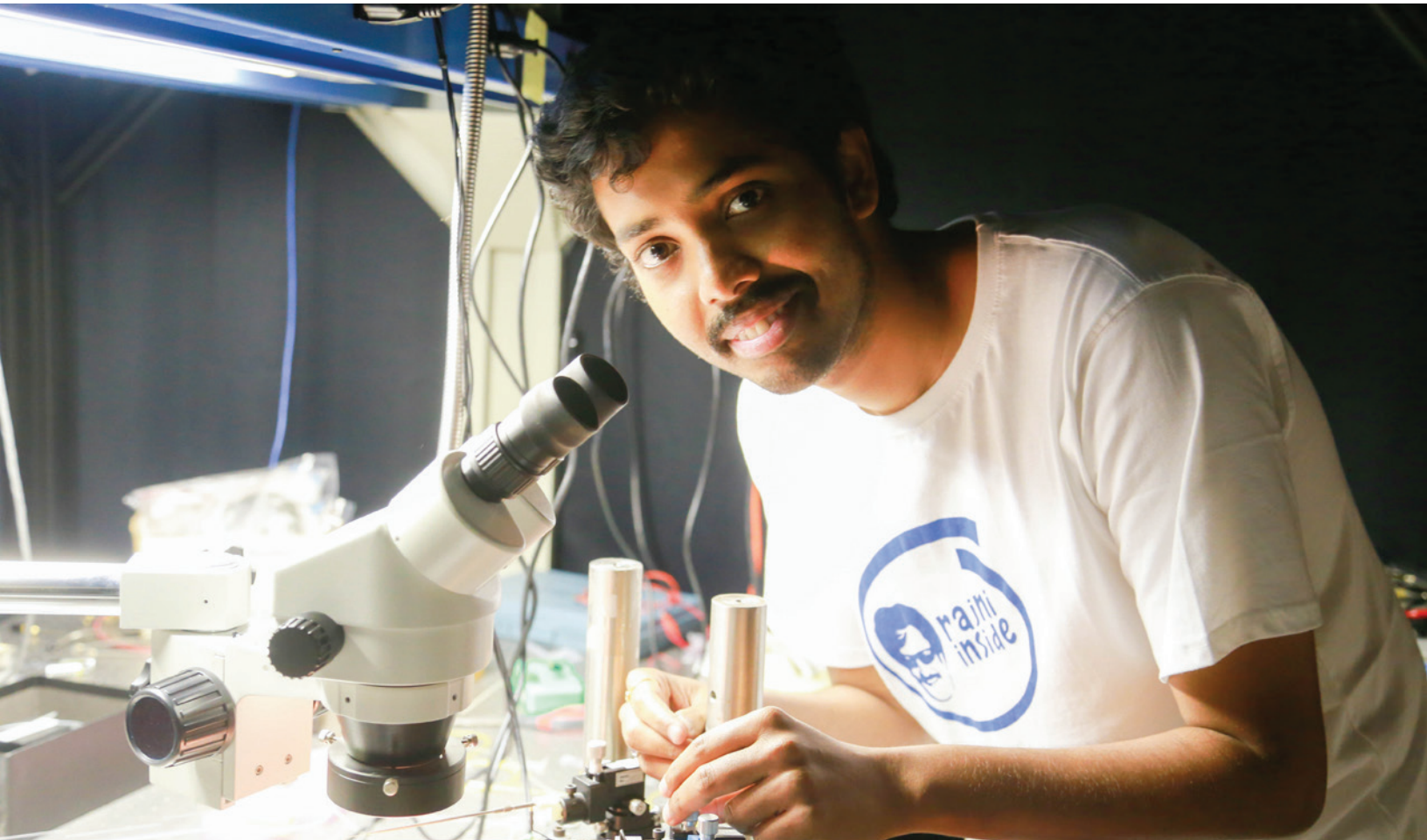


A wide bandwidth and low voltage electro-optic modulator, and an ultra-compact ring resonator.

modulation efficiency, which along with 0.2 V drive voltage are world records. Very wide bandwidth versions of such electro-optic modulators have also been demonstrated with drive voltages less than 0.7 V and bandwidths more than 67 GHz. For this device, electrode length was 10 mm. Devices with shorter electrode lengths have higher drive voltages but they also have much wider bandwidths. Devices with 3 mm long electrodes have bandwidth larger than 100 GHz. The drive voltage of this device could be 1.4 V. These are the lowest drive voltage and widest bandwidth optical modulators ever built. Fabrication of these modulators requires designs based on substrate removal technology developed in Professor Dagli's group. Required modulation is achieved using the physical effects available in compound semiconductors. An appropriate compound semiconductor epitaxial layer is grown on a substrate. This epitaxial layer is glued on to a transfer substrate after its front side is processed. This allows processing of the back side of this epitaxial layer as well. This allows fabricating any conceivable design.

Ultra compact and very low power integrated ring resonators

Another area studied in Dr. Dagli's group is photonic integration (PI). PI has the potential of increasing functionality, reliability, and reducing cost and power consumption. But this requires efficient and very compact devices. A recent example of work in this direction is the ultra-compact ring resonators made using conventional optical waveguides. Ring resonators have application in filters, modulators, delay lines and lasers. Dr. Dagli's group recently fabricated ultra-compact resonators using conventional waveguides, total internal reflection (TIR) mirrors and etched beam splitters (EBS). In a GaAs/AlGaAs ring resonator with 55 μm circumference, 11.5 nm free spectral range and 12 dB extinction ratio were demonstrated. It is possible to tune the transmission spectra of such a resonator using InP material system and active/passive integration. These devices demonstrated 45 μm circumference and 14.5 nm free spectral range. It is possible to change the extinction ratio of this device about 10 dB with just a few mA of current. So this very compact device can work as an efficient switch or modulator. The material platform used is based on conventional waveguide and active/passive integration, hence allowing full photonic integration.



Q&A: JOSE HERNÁNDEZ

Jose Hernández received his M.S. in ECE from UCSB in 1986. He was an astronaut for NASA during space flight STS-128 Discovery and helped establish the Reaching for the Stars Foundation to inspire young people to learn math and science.

Q: Your path to UCSB was a lot different than many other students. Where are you from and what was your life like growing up?

Jose Hernández: I grew up in the Central Valley in Stockton, California, but I came from what I would call a typical migrant farm working family. To better understand how I grew up: my family is originally from Michoacán, Mexico. We would typically spend nine months here in the U.S. and three months in Mexico, and during those nine months we would make a two-day trip to Southern California from Michoacán. It took two days to drive up to the border. We used to work in the strawberry harvest. I stayed there about a month and a half, went to school Monday through Friday, but on the weekend we worked side by side with my parents picking strawberries.

Q: You completed your undergraduate degree at University of the Pacific in electrical engineering, and then you attended UCSB for graduate school. What were some of your expectations when you came to UCSB?

The first couple of years were tough. Engineering curriculum, you know, you get all the weed-out courses: chemistry, physics, Fortran programming, calculus. You survive and then you go through your junior and senior years, then all of a sudden you get confident. At that point I knew I wanted to be an astronaut. I knew a bachelor's degree wasn't going to cut it, that I needed at least a master's degree, if not a Ph.D. I started looking at graduate programs and noticed that the electrical engineering program at UCSB was a Top 5 program.

I started UCSB with a little bit of graduate work credits from Stanford so I was able to finish the [M.S.] graduate program in one calendar year. I took heavy loads, but it was the very first time I didn't have to work and go to school, so it wasn't even hard for me. All my life I had been working and going to school. This time I had a full ride fellowship to go to UCSB and even had enough money to pay my rent. I was able to finish up in one year and it was a great program. I learned a lot and developed a lot of my leadership skills as a graduate student there because I helped the undergraduate students. It was a great experience. I love Santa Barbara – it's a beautiful campus. Quite frankly, I'm not sure I would have survived as an undergraduate because the campus is so beautiful. I would want to go to the beach every day. But as a graduate student I had a little more discipline.

Q: Your mentor at UCSB was Professor Sanjit Mitra. What do you think was the importance of having a mentor like that, someone that pushes you in your academic goals?

If you're going to embark upon a graduate program it is very, very important to align yourself with a mentor in the graduate program that you're studying in. For example, I was in electrical engineering, and Dr. Mitra is a great electrical engineer. I got into his research group, did some research for Dr. Mitra in Fourier transforms. You learn so much from someone like that, who has sort of the academic view of engineering. It gave me the ability to apply all the theoretical concepts into practical applications, which I did at Lawrence Livermore Lab. Work with someone who is doing research in your area of interest and then work your way into their lab, even if they don't pay you.

Q: You've continued to give back and do things with UCSB. What motivates you to continue to give back to your alma mater?

What motivates me is just motivating other kids to reach their full potential. I think one of the biggest problems with us as individuals is that we are our biggest barriers. We limit ourselves because we believe we can't overcome obstacles. I remind them: this is where I came from, this is how far I've come, and look at what I was able to accomplish through pure perseverance. You can't give up on yourself; you have to believe in yourself. When you believe in yourself, and prepare yourself, and are willing to work hard, just about any goal you set for yourself is achievable. That's what I try to instill in the kids. I see that they do listen and they do receive that very well.

Q: Many successful students come from UCSB's ECE Department. What do you think makes the program so successful?

I think the important thing about UC Santa Barbara, especially the College of Engineering, is that the University combines both the undergraduate programs and access to the graduate programs so that you do the academics and then you're able to do research at the same time. It is very important to involve a student as early as possible in the research process. I think that's what makes a student a bit more of an independent thinker, an originator of ideas. There is opportunity for undergraduates to get involved in research because that's putting you much further ahead than other students in critical thinking skills, analytical skills, and developing all of that can make you a better engineer.

FOR AN EXTENDED VIDEO INTERVIEW, PLEASE VISIT ECE.UCSB.EDU

EE CAPSTONE TEAMS COMPETE IN UCSB NEW VENTURE COMPETITION

Each year senior electrical engineering students are given the opportunity to enroll in a yearlong design course commonly referred to as "Capstone." The program, coordinated by Dr. Ilan Ben-Yaacov, Lecturer in the ECE Department and Technology Management Program, gives students the opportunity to tackle a challenging design project. Small teams, comprised of 3-4 students, are tasked with designing and building a real-world electronics product, which is of interest to their project sponsor, typically a UCSB research group or a corporate sponsor. Projects generally involve hardware design as well as software coding and implementation. Throughout the year, students work on perfecting their projects which are demonstrated at the annual ECE/CS Capstone Presentation Day the following June.

The EE Capstone course teaches students to address and create a solution to a problem. Students are tasked to know how to assemble and implement their products. Within the area of computer and electrical engineering, presentations cover topics such as energy generation, conversion systems, electrochemical and biological sensors, image processing systems, control systems and circuits, and solid-state lighting systems. During the course, students create prototypes and test their designs. Through their research, the groups find ways to refine their designs. Not only must their ideas be innovative, but they also must provide budgets and specifications of their projects. While students apply learned concepts and turn their ideas into practical products, they also gain the opportunity to show their work to outside sponsors.

In past years, several capstone teams have taken their projects beyond the scope of the course to develop their products while simultaneously competing in the UCSB New Venture Competition (NVC), run by the UCSB Technology Management Program (TMP). Two of these teams, Phone Halo and BrightBlu (now Zuli, Inc), were NVC award winners, and subsequently founded start-up companies based on the products they developed.

DR. ILAN BEN-YAACOV

"NOT ONLY DO STUDENTS GET AN OPPORTUNITY TO WORK ON EXCITING AND CHALLENGING DESIGN PROJECTS, BUT THEY ALSO RECEIVE GUIDANCE AND MENTORSHIP FROM UCSB FACULTY AND FROM INDUSTRY PARTNERS WHO ARE EXPERTS IN THE PROJECTS' FIELDS."

ALUMNI VENTURES

For more info, visit tmp.ucsb.edu/nvc

Phone Halo's upcoming TrackR Bravo tracking device.

Zuli smartplug and accompanying app.

Phone Halo, Inc.

UCSB Engineering alumni Chris Herbert (EE) and Christian Smith (ME), founders of Phone Halo, Inc., completed a Capstone project that involved developing a tracking device that paired with a user's cell phone, which helped them keep track of all their valuables. Today, with a team of 8 employees and growing, they are finalizing the design and manufacturing of their sixth item-tracking device.

Zuli, Inc.

UCSB Electrical Engineering alumni Taylor Umphreys, Sid Bhargava, and Ben Chang teamed up to form EE Capstone team BrightBlu, which aimed to develop a product that would allow users to control lights and other home appliances with their smartphones. This effort subsequently became Zuli, Inc. which launched late last year following a successful Kickstarter campaign.

2014 CAPSTONE WINNERS

The EE Capstone design projects are coordinated by Dr. Ilan Ben-Yaacov, Lecturer in the ECE Department and Technology Management Program. For more information or to become involved as a sponsor or mentor, please contact Dr. Ben-Yaacov.

Best Electrical & Computer Engineering Capstone Project Prize

Weihan David Wang Computer Engineering Capstone Poster Prize (co-winners)

James Cheng-Yuan Hong Best Computer Engineering Capstone Project Prize

Weihan David Wang Computer Engineering Capstone Poster Prize (co-winners)

George Chen Best Computer Engineering Capstone Project Prize

STUDENT SPOTLIGHT

"As scientists and educators, we have the responsibility to expose minority and underprivileged students to the basics of science and engineering from early on. Robotic networks have a great potential for capturing the imagination of the students," said Associate Professor Yasamin Mostofi, who has leveraged her research on robotic networks for outreach activities.

In 2014, Professor Mostofi partnered with Gallup Central High School and UCSB SACNAS (Society for Advancement of Chicanos and Native Americans in Science) to plan an exciting outreach program. Gallup is located in New Mexico, bordering Arizona, and is predominantly a Native American nation. Despite the significant cultural contribution of this group, the area is plagued with a high unemployment rate, and other problems. As such, the students of Gallup Central High School often lack interest in their curriculum, especially math and sciences. Professor Mostofi had worked with the educational counselor of Gallup High School at a different school a few years ago, and thus came to learn about Gallup High School. After some rounds of discussions, it became evident that Gallup High School could benefit significantly from an organized outreach event at UCSB.

Every year, UCSB SACNAS chapter organizes an event for the Hispanic and Native American students of central and southern California, with the goal of motivating students to pursue careers in STEM-related areas. In order to facilitate the visit of the Gallup students, Professor Mostofi partnered with the UCSB SACNAS program. With the funding support from both SACNAS and National Science Foundation (NSF), Professor Mostofi arranged for two STEM teachers and 5 students of Gallup High School to travel to UCSB for five days and take part in the annual SACNAS program in April of 2014. The incoming students partnered with UCSB students, visited different research facilities, and learned about college life. Professor Mostofi also gave talks on robotic networks to all SACNAS students and her research group gave demonstrations of their robots seeing through walls.

"My research group and I had an absolutely amazing time interacting with the SACNAS students, in particular the Gallup High students and teachers," commented Professor Mostofi. By all accounts, the Gallup High School students also had a fun and successful visit while learning about potential education and career possibilities, and (for some) getting their first chance to experience airplane travel and get a glimpse of the Pacific Ocean. Professor Mostofi plans to maintain her relationship with Gallup High School and looks forward to similar outreach opportunities in the future.

FACULTY AWARDS AND HONORS

Kaustav Banerjee

Awarded Invitation Fellowship of the Japan Society for the Promotion of Science.

The JSPS Invitation Fellowship for research in Japan is aimed at promoting international scientific exchange while advancing research in the subject field. The Japan Society for the Promotion of Science created the program to honor and attract renowned researchers to Japan for cooperative projects.

Larry Coldren

2014 IEEE David Sarnoff Award

Professor Coldren is being honored by IEEE with the 2014 IEEE David Sarnoff Award. IEEE is the world's largest technical professional association. The award, sponsored by SRI International Sarnoff, recognizes Dr. Coldren for his contributions to semiconductor lasers and photonic integrated circuits.

Steve DenBaars

Fellow of the National Academy of Inventors (NAI)

Election to NAI Fellow status is a high professional distinction accorded to academic inventors who have demonstrated a highly prolific spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on quality of life, economic development, and the welfare of society.

B.S. Manjunath

Best Paper Award, IEEE Transaction on Multimedia, 2013

Title: Video Annotation Through Search and Graph Reinforcement Mining, co-authored with former Ph.D. student Emily Moxley (now at Google) and collaborator Tao Mei (Microsoft Research, Beijing).

Michael Melliar-Smith

2014 Jean-Claude Laprie Award in Dependable Computing

Professor Melliar-Smith and colleagues at SRI International were given the prestigious 2014 Jean-Claude Laprie Award for their Software-Implemented Fault-Tolerant (SIFT) computer for aircraft flight control.

Dmitri Strukov

2013 Hellman Family Faculty Fellowship – "Race logi"

The purpose of the Hellman Fellows program is to provide substantial support for the research of promising assistant professors who show capacity for great distinction in their research.

RETIRING FACULTY

Louise Moser

After 25 years with the ECE Department, Professor Louise Moser is retiring, leaving a legacy of exemplary teaching, research and service to the Computer Engineering program, the Department, the College, and the University. Dr. Moser joined the ECE faculty in 1989 after serving as a Professor of Mathematics and Computer Science at California State University, a Researcher at Stanford Research Institute, and a Visiting Professor in the Computer Science Department at UCSB. She received her Ph.D. in Mathematics from the University of Wisconsin, Madison.

Professor Moser's research spans the areas of distributed systems, computer networks, and software engineering. At UCSB, she has served as Principal Investigator for many funded research projects, including projects from NSF, DARPA, AFOSR, UC Micro and UC Discovery. She has authored or co-authored over 290 conference and journal publications, and she holds 12 patents. Professor Moser has served as Associate Editor for the IEEE Transactions on Computers, the IEEE Transactions on Services Computing, and Area Editor for the IEEE Computer magazine.

Michael Melliar-Smith

Professor Michael Melliar-Smith is retiring after 27 years of dedicated and distinguished service to the ECE Department, the Computer Engineering program, the College, and the University. With a research focus on fault tolerance, distributed systems and computer networks, Professor Melliar-Smith's acclaimed career has included more than 290 publications, more than 12 patents, and a variety of awards. Most recently, Dr. Melliar-Smith, along with his colleagues at Stanford Research Institute, won the 2014 Jean-Claude Laprie Award in Dependable Computing for their Software-Implemented Fault-Tolerant (SIFT) computer for aircraft flight control.

Prior to joining UCSB, Professor Melliar-Smith worked as a Senior Computer Scientist and Program Director at Stanford Research Institute, where he collaborated on the SIFT aircraft flight control. At GEC Computers, he was the Principal Designer of the GEC 4080, which won the Queen's Award for Innovation. At the University of Newcastle upon Tyne, Dr. Melliar-Smith invented the definitions of fault, error and failure, as well as the recovery block method for fault tolerance. He received his Ph.D. in Computer Science from the University of Cambridge, England.

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Invest in the Department of Electrical and Computer Engineering

The goal of the Department of Electrical and Computer Engineering at UC Santa Barbara has always been to provide our students with the best possible opportunities to learn and develop. The faculty, students, and administration have created an atmosphere of interdisciplinary and collaborative research that is renowned throughout the Nation and is the cornerstone of our success.

Your investment in the Department of Electrical and Computer Engineering plays a critical role in our ability to fulfill our mission and provides essential support of ECE's teaching program and research enterprise.

Department funding opportunities include:

- **Unrestricted support** to be allocated to the highest priority needs of the Department.
- **Roger Wood Endowment**, established in honor of esteemed faculty member Roger C. Wood, supports undergraduate and graduate fellowships, faculty, and state-of-the-art teaching facilities.
- **Undergraduate laboratory** renovations to maintain and upgrade the quality of essential facilities for teaching and research. Priority renovations and naming opportunities include: Digital Lab, Controls Lab, Computer Engineering Lab, High Speed Communications Lab, Microwave Lab, Digital Signal Processing Lab, and the Instructional Clean Room.
- **Endowed chair establishment**, which honors, encourages, and supports the professors whose brilliant minds and commitment to education and research promote the University's mission.
- **Petar V. Kokotovic Distinguished Visiting Professorship**, established by Dr. Kokotovic's former students and colleagues as a vehicle for honoring and recognizing his contributions to UCSB students, the UCSB campus, and the academic community. The fund supports an annual named distinguished visiting professorship.

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