THE ECE CURRENT

FALL 2022

UC **SANTA BARBARA**

Electrical and Computer Engineering

College of Engineering

Research Initiatives

ECE Alumni Spotlight

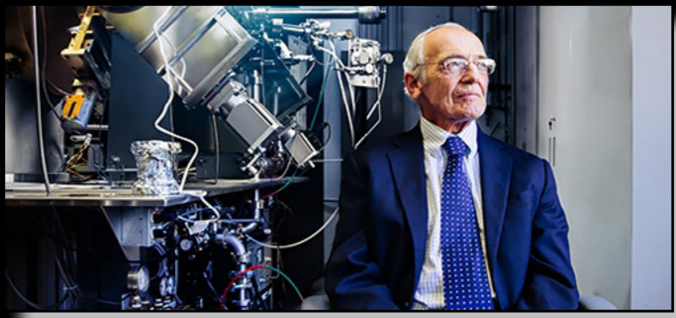
On the Cover: Migrating cells. In living organisms, cells are often on the move: they migrate in order to realize tasks that are essential to life. Professor Nina Miolane Research. See pages 6 & 7 for more information.

Letter from the Chair

Greetings!

We begin the Fall 2022 academic year on an optimistic note as we welcome our new cohort of CE and EE majors and graduate students, faculty and staff back to campus. Two new faculty members joined us this year, Haewon Jeong and Yao Qin, whose research is in the broad areas of computer engineering and machine learning. Congratulations to Professors Mahnoosh Alizadeh and Ramtin Pedarsani on receiving tenure. Over the past year the department has undertaken an extensive revision of the undergraduate curriculum, offering students more flexibility and with the goal of training the next generation of electrical and computer engineers. The revised curriculum is effective for the incoming 2022-23 majors. This year we also have the largest number of students joining our CE and EE majors in the department's history and graduated 37 PhD and 49 Master's students during the 2021-22 academic year. The department continues to leverage strong extramural research support, with an average annual funding of $25 million over the past three years. The department is ranked in the top 10 in the newly released Shanghai ranking, continuing the tradition of teaching and research excellence. We look forward to another great year of productivity.

B.S. Manjunath, ECE Chair



In Memoriam: **Arthur Gossard** 1935 - 2022

Born June 18, 1935 in Ottawa, Illinois, Gossard received his BA in physics from Harvard University in 1956 and a PhD in physics from UC Berkeley in 1960. In his doctoral research, he observed the first nuclear magnetic resonance in a ferromagnetic material and discovered the enhancement of a radio-frequency magnetic field at the nucleus caused by domain rotation and domain wall motion. He then went to work at Bell Labs, where he became a senior member of the technical staff during his service, which lasted from 1960 to 1987. His research there involved molecular beam epitaxy, the growth of quantum wells, nanostructures and superlattices and their applications to high-performance electrical and optical devices and the physics of low-dimensional structures.

Gossard was a pioneering scientist in materials that would enable the revolution in electronics and photonics. Working closely with UCSB professor and eventual Nobel Laureate Herb Kroemer, Gossard spearheaded the use of a then-novel technique — molecular beam epitaxy (MBE) — a method of "growing" a thin film of one material on top of another by depositing each layer, atom by atom, in an ordered fashion.

Over his career, Gossard wrote more than thirteen hundred research papers and received numerous awards including the 1983 Oliver Buckley Condensed Matter Physics prize and the 2001 James McGroddy New Materials prize from the American Physical Society. He was elected to the National Academy of Engineering in 1987 and to the National Academy of Sciences in 2001. He received the U.S. National Medal of Technology and Innovation in 2016.

Gossard actively contributed to UC Santa Barbara throughout his career. He served as Associate Vice Chancellor for Academic Personnel from 2006 until he retired in 2010. He was an avid and competitive sailor and bicyclist throughout his life and commuted to campus for much of his time at UCSB, into his 80s.

UC Santa Barbara, the UCSB College of Engineering, and the materials science and engineering world more broadly lost one of its giants with the passing of UCSB professor emeritus Arthur C. Gossard, who died on June 26 in Santa Barbara. He is survived by his wife, Marsha, his daughter, Sue, his son, Christopher, and several grandchildren.

Welcome, New Faculty!

Haewon Jeong

Assistant Professor

Haewon Jeong received a PhD in Electrical and Computer Engineering at Carnegie Mellon University. Her thesis established important foundations on how we can apply coding theory to building reliable large-scale computing systems. Before joining UCSB, she was a postdoctoral fellow at Harvard University, where she explored reliability in a different sense: how to build a machine learning system humans can trust and rely on. In particular, she investigated how machine learning systems can discriminate against students in education-related applications, and how we can build more fair machine learning algorithms. She is passionate about social justice in education and has actively participated in outreach programs teaching math and science to underprivileged K-12 students.

Her work has been published in a wide range of journals and conferences including Proceedings of the IEEE, IEEE Transactions on Information Theory, Conference and Workshop on Neural Information Processing Systems, Proceedings of the AAAI Conference on Artificial Intelligence, IEEE International Conference on Big Data, and European Conference on Parallel Processing. She has organized the ICML-21 Workshop on Information-Theoretic Methods for Rigorous, Responsible, and Reliable Machine Learning and the ISIT 2022 Tutorial on Information-Theoretic Tools for Responsible Machine Learning. Her research team will marry different fields (e.g., Information Theory, Statistics, Machine Learning, Distributed Systems) to develop theoretically-grounded tools for trustworthy and reliable machine learning systems.

Yao Qin

Assistant Professor

Yao Qin received her PhD in Computer Science and Engineering at UC San Diego in 2020. After that, she worked as a research scientist at Google Research. Her research focuses on robustness of machine learning, including adversarial robustness and out-of-distribution generalization. In addition, Yao also has an interest in developing general machine learning algorithms and applying them to computer vision, natural language processing, and healthcare applications.

Yao has extensively published papers at the top conferences and journals, including Neural Information Processing Systems (NeurIPS), International Conference on Machine Learning (ICML), International Conference on Learning Representations (ICLR), Computer Vision and Pattern Recognition (CVPR), International Journal of Computer Vision (IJCV), European Conference on Computer Vision (ECCV), etc. Due to her contributions to the machine learning area, she has been selected as EECS Rising Star at MIT, 2021. During her PhD, Yao has interned at Brain Toronto Team advised by Geoffrey Hinton in 2019, and Google Brain Red Team advised by Ian Goodfellow in 2018.

FACULTY AWARDS & HONORS 2021-2022

1. **Jim Buckwalter**
   2022 IEEE Fellow
2. **Kerem Çamsari**
   2022 Office of Naval Research – YIP;
   2022 Scalable Probabilistic Computers for Optimization and Quantum Simulation
3. **Yoga Isukapalli**
   2021-2022 Outstanding Faculty Member award in Computer Engineering (CE)
4. **Umesh Mishra**
   2022 IEEE Jun-ichi Nishizawa Medal
5. **Sanjit Mitra**
   2021 Academia Nacional de Engenharia (ANE)
6. **Spencer Smith**
   2021-2022 Outstanding Faculty Member award in Electrical Engineering (EE)
7. **Zheng Zhang**
   2021 IEEE CEDA Ernest S. Kuh Early Career Award

STUDENT AWARDS & FELLOWSHIPS

Behm Scholarship

Abel Atnafu, Allison Lebus (CE)

Fang Fellowship

Emmanuel Kayede (EE)

Ed Hass Outstanding Junior Award

Anna Koh (CE)

Hynes-Wood Award

Daniel Hernandez-Vitela (EE)

Outstanding Seniors

Steven Lin (CE)

Arthur Wang (EE)

Outstanding Teaching Assistants

Connor Sanchez (CE)

Swetha Pillai (EE)

Outstanding Graduating Seniors

Emily O'Mahony (CE)

Daniel Hernandez-Vitela (EE)

Roger Wood Scholarship Award

Eric Hsieh (CE)

Sabrina Maldonado (EE)

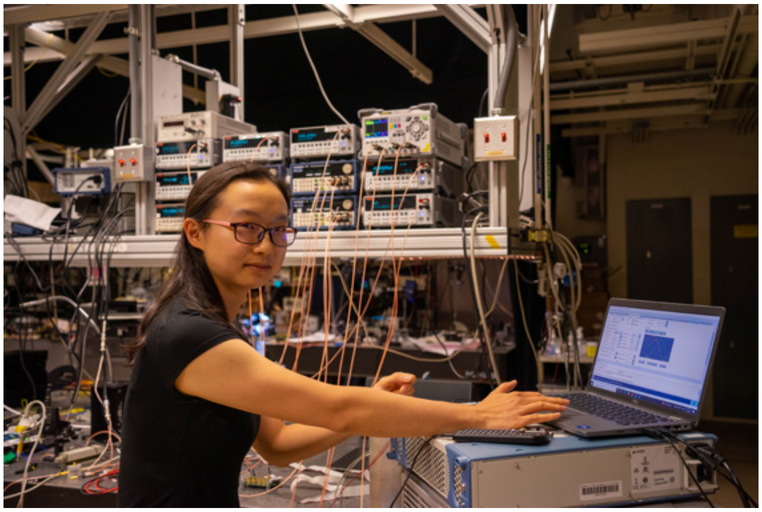
Rediker Scholarship

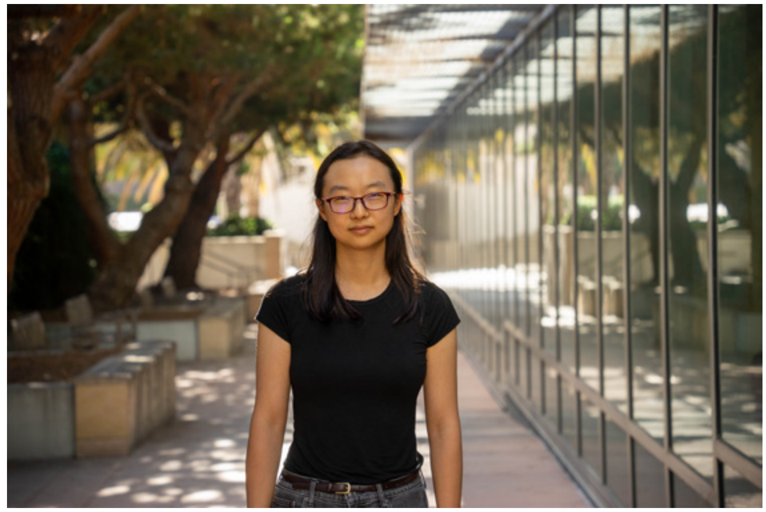
Jesus Oviedo (CE)

Daniel Van Dalsem (EE)

STUDENT SPOTLIGHT: **YUJIE XIA**

Advisor: Clint Schow





Why did you choose UCSB's ECE Department?

Firstly, because UCSB gave me a great offer. Also, I wanted to do research related to photonics, and I learned that UCSB is really strong in this area. Then, considering UCSB is so close to the beach-why not?

How did you learn about the program?

During the last year in college I did my final year-project in a group doing research on silicon photonics. The master's and PhD students there told me a lot about photonics-related research groups around the globe, and that's where I heard about UCSB.

What is campus life like for ECE students?

I'd say as grad students, we work very hard. But at the same time we also take advantage of campus resources to recharge ourselves, such as participating in campus activities and enjoying the hiking trails and the beach. We certainly spend a large percentage of our "campus time" in our labs, but other than that, I don't think our life is too different compared with students of other majors.

What prepared you the most for studying engineering in college?

I think the most important thing is to be eager to learn new things, and to be patient and willing to spend time to figure things out. Subjects like math and physics can be helpful, but attitude is more important, in my opinion.

What were some challenges you faced as a student/researcher?

As one of the first students in my advisor's group, the learning process was challenging since there weren't senior PhD students and postdocs in the group to guide me. And sometimes it is difficult to have faith in myself when I didn't know if I could ever get any results from what I was doing, since nobody in the group had done similar things before. Building something from the very beginning is a rewarding experience, but it can be hard when I see that my progress is much slower than others in terms of publication.

Students and parents often ask, what can you do with an electrical engineering degree?

Electrical engineering is a broad area, and there are a lot of interesting things to work on. You can choose to focus on hardware such as electronics and photonics, or choose to be more oriented towards algorithms, signal processing, etc. Also, there are many interdisciplinary areas to explore if you'd like. For example, people work on circuits and photonics for bio and health applications. In terms of what kind of jobs you can take after graduation from a PhD program, academia is an option, and there are also a lot of opportunities in industry. However, most importantly, the education will get students prepared for the future with a solid foundation of problem solving and critical thinking skills, so you can still do well even if you decide to take a different path after graduation.

Can you tell us about anyone you looked up to?

I can't name a particular person here because I look up to a lot of people around me, when they treat people with kindness, when they stay positive and keep trying during difficult times, and when they remain warm and tender despite life trying to harden them. In general, I always learn a lot from all the people I spend time with.

What have you learned that has surprised you the most so far?

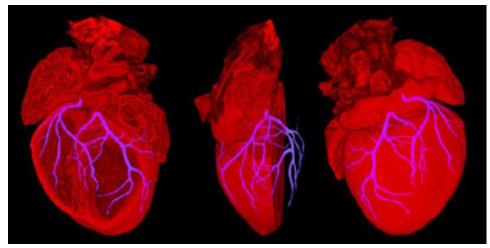
I learned that things typically don't happen the way you wished (well, this part is not surprising I guess...), but the way things happen can still be good, just different.

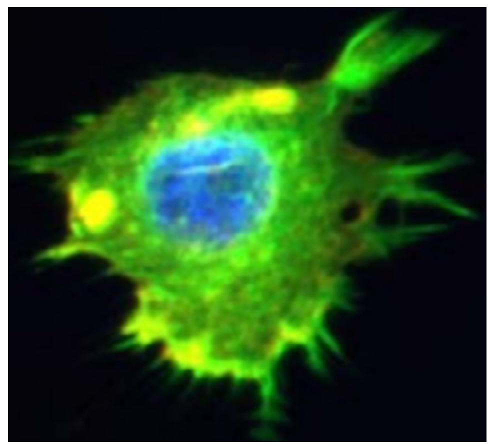
Is there anything else you'd like to share regarding the department, your program, or UCSB?

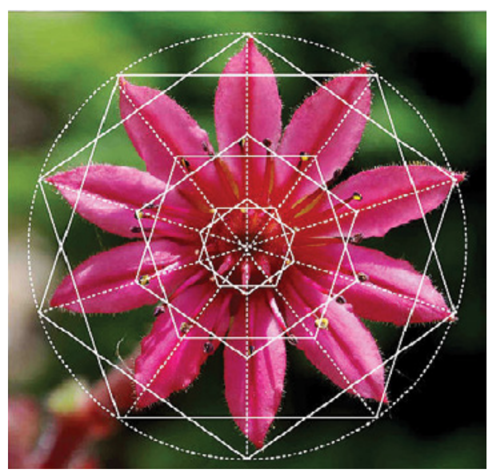
On the first floor of ESB there's a really nice cleanroom facility. Sometimes the staff offer a tour and you should definitely check it out if you've never been there. I haven't been working there for a while, but I certainly learned a lot while working there.

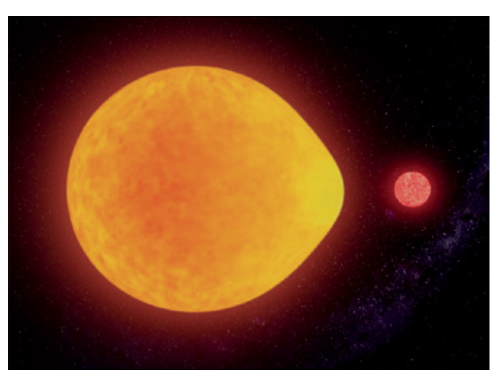
Nina Miolane

THE BIOSHAPE LAB @ UCSB ECE









Natural shapes have always captivated the human eye:

from the geometric patterns of the brain cortical surface, to the fractal design of the heart's vascular system, the intriguing universe of cell shapes, the stylish arrangement of petals in a flower, or the mesmerizing dances of pulsating stars. Beautiful examples of shapes are ubiquitous in natural sciences. To the BioShape Lab however, these shapes also carry valuable information: How do they arise? Which functions do they fulfill? Are questions that the BioShape Lab members seek to tackle with ever finer quantitative tools.

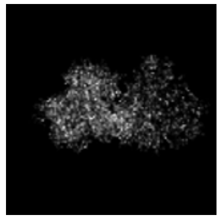
Nature abounds with beautiful shapes: brain cortical connections, cardiovascular fractal patterns, cell morphologies, petal symmetries, and pulsating stars. Images credits: Greg Dunn Neuro-Art, British Art Foundation, Ashok Prasad, Matematik Dunyasi, Gabriel Pérez.

In the biological and medical fields,

advances in biomedical imaging have enabled us to access the 3D shapes of a variety of structures: proteins, cells, organs. Since biological shapes are related to physiological functions, this shape data holds the key to unlock outstanding mysteries in biomedicine.

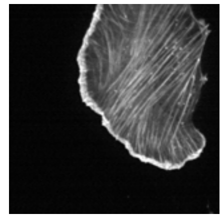
Considering shapes at the nanoscale, the aggregation of misfolded proteins in the central nervous system characterizes a number of neurodegenerative diseases, such as Parkinson's and Alzheimer's. At the microscale, the health of actin - proteins involved in important cell processes including cell division - correlates with cell shapes, which are thus critical for the diagnosis of cancer types and stages. At the macroscale, organ shapes describe a wide range of diseases, for instance pathological heart shapes found in stress cardiomyopathy where the main pumping chamber changes shape, reducing the heart's ability to pump blood effectively. As vast quantities of shape data can now be generated by high-throughput imaging systems, providing appropriate and reliable tools to study biological shapes is critical and timely.

Proteins change shape to fulfill their role in the cell



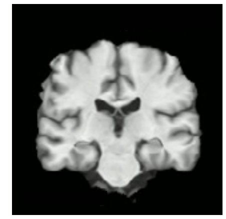
Heat-shock protein 90: Folds to stabilize other proteins against heat stress

Cells adopt different shapes as they react to drug treatments



Cancer cell: Changes shape as it reacts to cancer drugs

Organ shapes provide insights on disease progression



Azheimer's disease: Characterized by brain shape changes

Biological Shapes:

are correlated with physiological functions and entail crucial quantitative information about normal and pathological conditions in biomedicine.

While the human eye recognizes shape differences in a heartbeat,

defining an exhaustive quantitative taxonomy of shapes still remains difficult. Human languages only possess a limited set of adjectives (concave, convex, connected, elongated, among a few others) that fails at providing precise shape descriptors. In this context, the BioShape Lab's research aims to create precise, quantitative computational descriptions of shapes, with associated machine learning algorithms and statistical theory implemented in their software Geomstats, to reveal the science behind the beauty of biological shapes and communicate to the wider audience about their findings.

Lab meeting in the BioShape Lab, with Adele, Mathilde, Francisco, Bongjin and Sophia.

Professor Spencer LaVere Smith stands in front of a laser scanning imaging system his lab designed and built to measure and manipulate neural activity in living animals with single cell resolution.

New Frontiers of Computing with Neurons and Optics

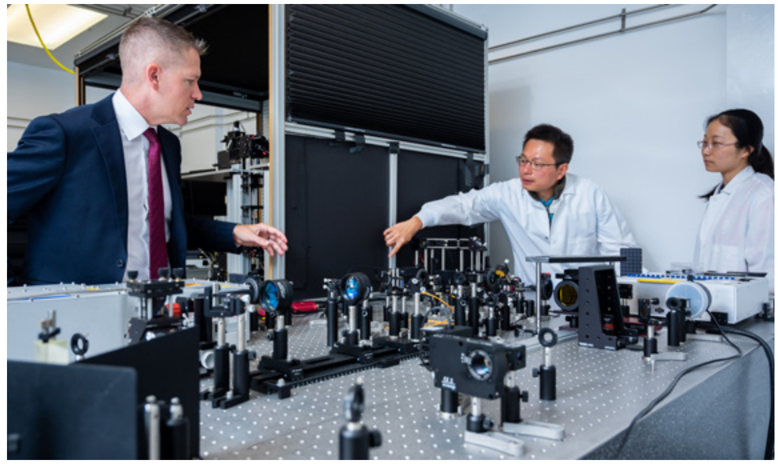
ECE Professor **Spencer LaVere Smith** develops complex quantum mechanical imaging systems to precisely reverse engineer how the brain works

Modern artificial neural nets (ANNs) are a class of machine learning approaches that are inspired by the brain. ANNs are the leading approach for a range of problems including processing of image and video data, translating natural language, and navigation in self-driving cars and drones. Are there further insights into computation locked away in the brain? There must be, because even simple animals with small brains can outperform our best machines in some tasks. For example, mice can navigate complex worlds using vision alone, reliably and quickly, with rather poor image sensors (their tiny eyes) and a brain that runs on less than one watt of power. Spencer LaVere Smith's research program is working to uncover new insights to computation in brains.

But there is a problem. The brain is very complex, and our tools for investigating it are limited. For example, brain activity imaging techniques are either low resolution, such as magnetic resonance imaging (MRI) which is related to blood flow or blood oxygenation, or high resolution like two-photon calcium imaging, but with only very small fields of view. So, there are two halves to the lab: half of the lab develops new tools and techniques, and the other half then uses these tools in neuroscience experiments to gain insights into computation in brains.

Most of the engineering is optical in nature, based on two-photon excitation of fluorescent proteins that are genetically engineered to report neural activity. Two-photon excitation is a quantum mechanical phenomenon, and depends on high power ultrafast lasers. The lab has pioneered large field-of-view two-photon imaging systems, which are high enough resolution to see individual neurons and synapses, with large enough fields of view to see multiple brain areas simultaneously. To examine the brain in action, the lab also develops virtual reality (VR) systems for mice. Mice show off their visual navigation skills while the lab images the brain activity underlying these feats. Next, sophisticated data analysis and modeling is used to gain insight into neural circuitry, and ultimately help create new and improved ANN technology.

Recently, the lab's interest in computation and their expertise in optics have led to a new branch into optical computation. Von Neumann style computation is the fundamental design used in most computers, smartphones, and other computation devices we encounter. However, ANNs use computations that can be quite inefficient with this approach. Optics can be used to develop co-processors that offer improved speed and energy efficiency. For example, freespace optics offer a geometrically scalable approach for large fanouts, and Fourier transforms can be performed at the speed of light with very little energy usage, based on the physical principles of refractive lenses and interference within a coherent wavefront.



Smith speaks with Dr. Che-Hang Yu and Dr. Yiyi Yu about the optics used to shape the ultrafast laser pulses for the imaging system. These laser pulses are guided to the brain and used to measure and manipulate neuronal activity with single cell resolution. Their custom systems can optically access over a million neurons within a single field-of-view.

> To uncover powerful principles of brain function, we need to measure neuron-resolution brain activity while the animals are doing something that they are experts at.

Mice are expert visual navigators— doing so more efficiently and reliably than the best human-made technology. To study how brain circuitry supports this expert behavior, researchers have mice walk on a spherical treadmill surrounded by screens displaying a virtual reality (VR) environment.

KEREM ÇAMSARI

Orchestrating Physics for Unconventional Systems (OPUS): Delivering Hardware Advances for the Beyond-Moore Era of Electronics

The field of electronics has been driven by Moore's Law for at least six decades. In the last decade or so, transistor and its modern variants have reached atomic dimensions and it is very difficult to continue scaling them. Meanwhile, enormous algorithmic advances in the field of Machine Learning and Artificial Intelligence (AI) have recently taken over the world. The success of "deep learning" led to larger and larger neural networks achieving impressive feats. We have now chatbots that can write newspaper columns or digital AI artists that can design magazine covers from simple English prompts. While these are incredibly impressive, there is an enormous cost behind these AI models in the energy, resources, and time they use.

Çamsari believes the beyond-Moore era of electronics will be defined by a creative combination of heterogeneous computing systems, blurring traditionally separate layers of abstraction from Physics to Systems

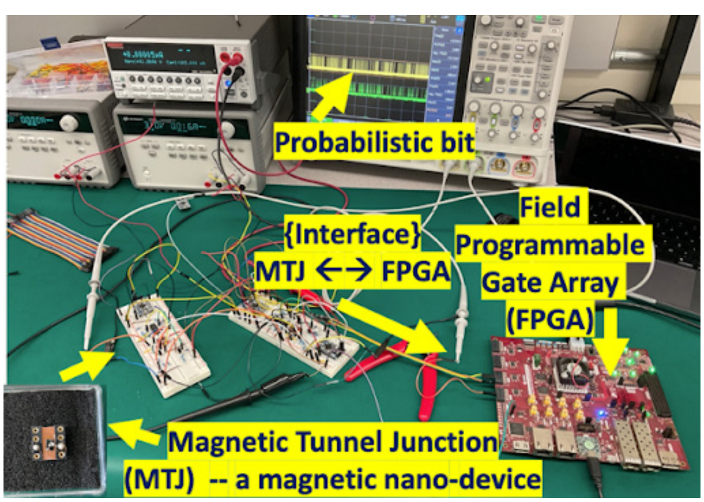


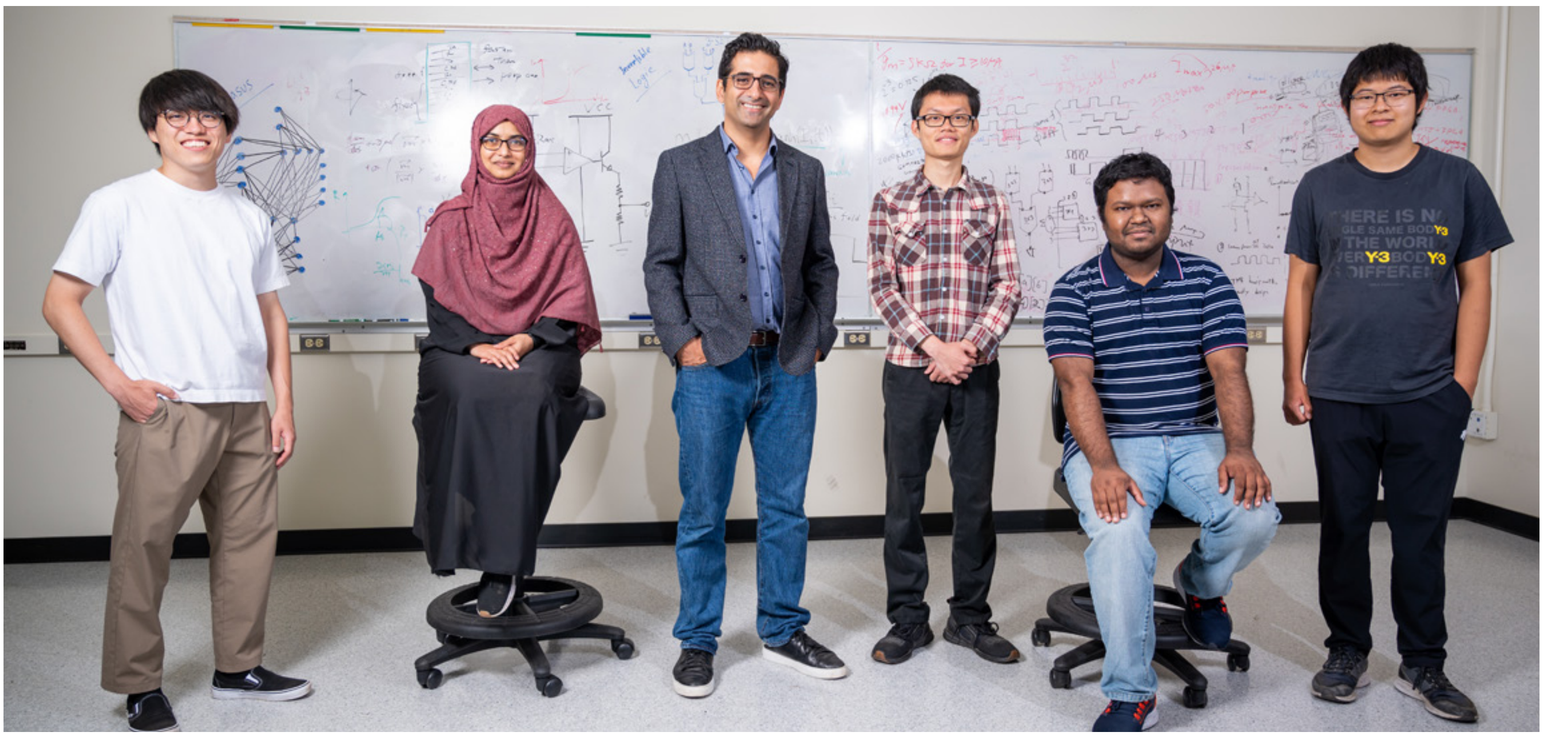
Figure 1 - We look for ways of augmenting existing CMOS technology with novel nanodevices to improve functionality and energy efficiency in computing: this example shows a combination of magnetic nanodevices with present day electronics to implement advanced probabilistic algorithms.

Given these insatiable computational demands in AI, a new thread of research with a steady following has emerged. The basic idea is to augment traditional computing hardware with new and emerging materials and phenomena by connecting new physics to the needs of algorithms and applications. This approach is sometimes summarized by the credo: "Let physics do the computing." In fact, this is a good description of the related field of quantum computing (QC): "QC is all about building computers out of quantum building blocks to solve "naturally quantum" problems, for example, quantum chemistry and solving the quantum many-body problem. In a similar vein, my lab is leading the development of probabilistic computers with p-bits, naturally suited to implement probabilistic algorithms and functionality. Probabilistic thinking is very common in modern AI and we believe p-bits may play an important role in energy-efficient, next-generation hardware for AI and computing.

Due to the interdisciplinary nature of this field, we are interested in various layers of abstraction in computing, from physics and devices all the way up to architectures and algorithms. We often employ what is known as co-design techniques where requirements in one layer of abstraction (e.g., devices) dictate how another layer (e.g., algorithms) should be modified. We spend a lot of time thinking how to combine different domains smoothly to one another. This makes our research highly interdisciplinary and students enjoy the all-around understanding they have to develop to be creative in this field.

Below: Some members of OPUS lab, from left to right, Keito Kobayashi, Shaila Niazi, Kerem Çamsari, Hongkuan (Ken)Yu, Navid Anjum Aadit, Qixuan (Shawn) Cao.

For a full list of OPUS Lab members and their biographies, visit: https://opus.ece.ucsb.edu/people



As an example of this Physics-to-Systems approach we follow in our lab, consider Figure 1. Here we make use of the natural noise encountered in magnetic nanodevices to build energy-efficient probabilistic bits to use them in conjunction with existing technology. Such ideas often require a deep understanding of the underlying algorithms to adjust them in hardware-friendly designs, which is the co-design aspect mentioned earlier. Another example of this thinking is our algorithm-architecture co-design result that recently appeared in Nature Electronics (Aadit et al., 2022). In that paper, we showed how modifying well-known algorithms to make them "sparse" and hardware-friendly could lead to massive parallelism, with substantial improvements in time and energy to solution for hard computational problems.

Going further, we believe scaling up novel CMOS + X style hardware where traditional CMOS hardware is enhanced with new and emerging technologies (X= magnetism, ferroelectricity, etc.), through heterogeneous integration in monolithic architectures and other methods, will eventually lead to success stories in the beyond-Moore era of electronics. At least this is our hope and vision for a more sustainable and equitable future in computing.

DAN BLUMENTHAL

Silicon Nitride Photonics: From Information to Atoms

WE ARE IN THE MIDST OF A NEW ERA of photonic integration, one that will impact a broad range of science, engineering, and applications, from data centers and fiber optic communications, to atomic clocks and our most precise ways to measure time (position and gravity), to harnessing the quantum nature of our universe for applications such as computing and sensing. This new photonic integration technology is needed to transform these fields, by moving today's lab-scale size lasers and optics to the chip-scale to improve reliability, reduce cost, size, and weight, enable portability, and allow experiments to scale to very large numbers of lasers and optics, much like how the transistor and very large scale integration (VLSI) did for computing. In the Blumenthal group at UCSB, we have pioneered "silicon nitride photonics," a new class of enabling integration technology, sitting at the intersection between the way we transmit information with light over optical fibers and the way we use light to interact with and manipulate atoms. Our group then takes these new integration technologies and conducts applications and systems research in areas related to optical communications and atoms. Silicon nitride (Si_3N_4) is a semiconductor material, used in standard CMOS electronics, that has unique properties related to its a wide bandgap that makes it an ideal optical waveguide with extremely low optical losses operating from the visible (405 nm) to the infrared (2350 nm). The Blumenthal group has demonstrated the lowest optical waveguide losses in the world, less than 0.035 dB/meter at telecommunications 1550 nm wavelengths and less than 0.01 dB/cm at key wavelengths associated with transitions of atoms such as strontium and rubidium (atoms used for atomic clocks and sensors). These waveguides have been used to set world records on other devices including the highest quality factor (Q) resonators in the visible and IR. The Blumenthal group today is made up of a team of highly talented PhD students, whose work is described in this article: Nitesh Chauhan, Debapam Bose, Jiawei Wang, Mark Harrington, Kaikia Liu, and Andrei Isichenko.

Our Si_3N_4 ultra-low loss waveguides are used to move light around on a chip called a photonic integrated circuit (PIC), and to create other important tools that can be integrated on the same chips, such as: such as: extremely narrow linewidth (spectrally-pure) lasers that can carry a lot of information and connect to atoms without disturbing their state; optical modulators for putting information on the light and allowing control of the light; stabilization cavities for stabilizing laser light and reducing its noise; and high performance diffraction gratings to form free space beams from waveguides to cool and trap atoms. By combining these technologies on the same chip, our group is integrating systems that normally occupy tabletops and racks, to the chip-scale. Since our waveguide technology supports light from the visible to the IR, we are able to address a wide range of applications spanning atoms to optical communications and cross-pollinate techniques between these different areas. For example, applying the stabilization of light in the atomic world to solve energy efficiency problems in the data center, the focus of our ARPA-E sponsored FRESCO (Frequency Stabilized Coherent Optical Links for Energy Efficient Communications) project. Our work is funded by a mix of government programs and industry funding, including the NSF, DARPA, and ARL. Examples of integrated silicon nitride systems-on-chip for communications and atom applications are shown in Fig. 1.

Our group is consistently pushing the forefront of new technologies that enable the creation and manipulation of light on a chip. With light so pure and optical losses so low, experiments which usually require labs filled with tables and racks of lasers, optics, and controls, can be moved to the chip-scale. For example, shown in Fig. 2a, published in Nature Photonics, our silicon nitride integrated Brillouin laser with under 1 Hz fundamental linewidth; such lasers before were built using fibers and discrete components in boxes. Also shown in Fig. 2, our 4-meter long integrated reference cavity, integrated PZT stress-optic modulator, and 200 mm CMOS wafer with 4-meter long reference cavities. Recently our group has reported the

> "Our group is consistently pushing the forefront of new technologies that enable the creation and manipulation of light on a chip."

world's first rubidium atom cooling and trapping using photonic integrated beam delivered in a 3-dimensional magneto-optic trap (3D-MOT) for the cooling and repump beams. A 3D-MOT uses a combination of six laser beams and magnetic fields to contain and cool atoms (in this case rubidium) for various applications including optical clocks and sensors. Typically such systems require discrete lenses, mirrors, and other components to deliver laser beams to a vacuum cell that contains the rubidium atoms. In this work we have constructed a rubidium 3D-MOT (shown schematically in Fig. 3a), that uses a silicon nitride integrated circuit (Fig. 3b) to convert laser beams from an optical fiber to waveguide to free-space beams that are input to the vacuum cell. In this experiment we successfully used our chip to cool over five million rubidium atoms to a temperature of 200 microkelvin (uK), as seen in Fig. 3c.

In summary, the potential for integrated systems on-chip using silicon nitride and associated integration technologies to transform applications from information to atoms will impact everything from fiber optical communications to atomic computing, sensing, and quantum systems. We will see a new era where lab-scale experiments move to the chip, enabling new science and portable applications, such as atomic clocks and gravitational measurements using atom interferometery in space, quantum computers and sensors that are able to manipulate and readout a large number of atoms or ions, fundamental particle detection and molecular science, and more, using a technology that is compatible with CMOS wafer-scale foundries and promises to continue to increase in performance and functionality.

fig. 1

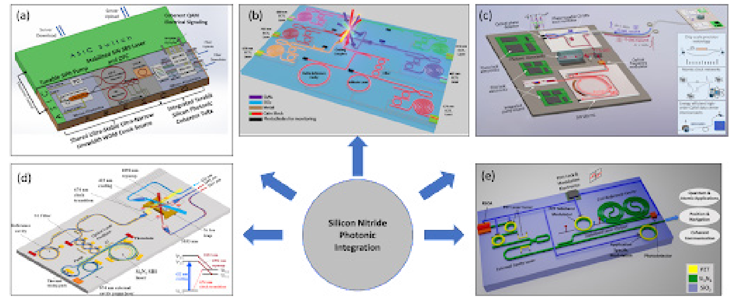


fig. 2

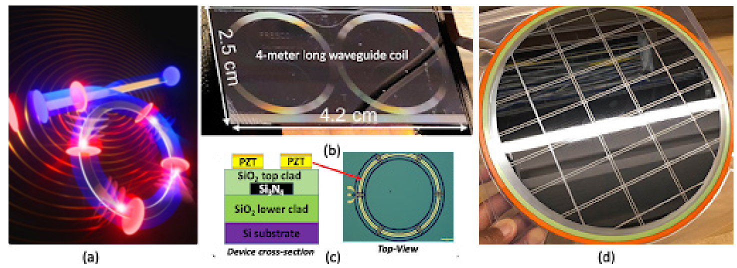


fig. 3

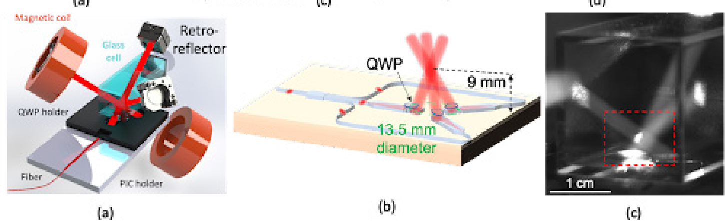
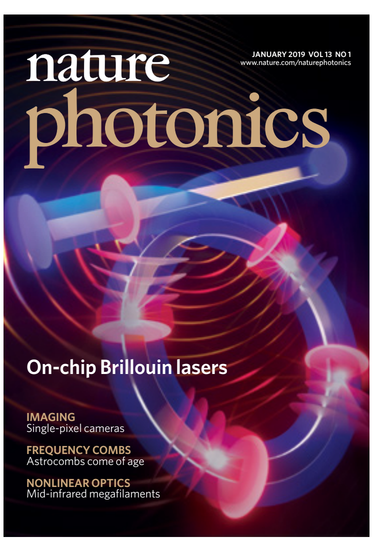
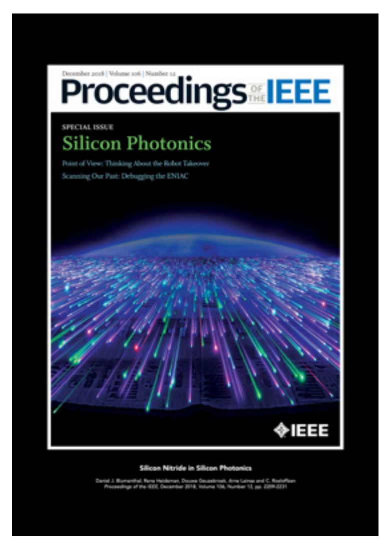


Figure 1. Examples of integrated silicon nitride photonic integrated circuits (PICs) for applications from information to atoms: (a) Energy efficient high capacity wavelength division multiplexed (WDM) fiber optic communications for data centers. (b) Multi-wavelength atom trapping and cooling for quantum computing and sensing. (c) Precision frequency and phase synchronized fiber optic links. (d) Trapped ion atomic clocks, computing, and sensing. (e) Frequency stabilized lasers.

Figure 2. Integrated technologies. (a) Sub-Hz fundamental linewidth integrated Brillouin laser. (b) 4-meter long silicon nitride reference cavity on-chip. (c) Integrated stress-optic PZT silicon nitride modulator. (d) CMOS foundry compatible 200 mm wafer with 4-meter reference cavities.

Figure 3. Photonic integrated beam delivery for atom cooling and trapping in a rubidium 3D-MOT. (a) 3D-MOT setup. (b) Silicon nitride photonic integrated circuit for converting cooling and repump laser from a fiber into free space beams that are input to a rubidium vacuum cell. (c) 3D-MOT operation with cooling and repump beams enter cell from bottom, cooling five million atoms to 200 uK temperature at the intersection point.





A sampling of high-impact journal covers from recent years which feature discoveries and inventions pioneered by Dr. Blumenthal and his lab groups.

WALLACE KOU

We spoke with UC alumni Wallace Kou, as he reflects on the impact the ECE program had on him and his success as founder of Silicon Motion.

Q: Please introduce yourself.

A: I got a master of electrical and computer engineering from UC Santa Barbara in 1985. I am the president and CEO of Silicon Motion today.

Q: Please talk briefly about Silicon Motion and the products that your company creates?

A: I am the founder of Silicon Motion, which I started in May 1995. Today, we are the largest NAND flash controller maker in the world. So, we are leading in the industry, providing controller solutions to many markets, such as personal computer, automotive, data center, many electronic consumer devices - probably close to a hundred different applications in the market.

Q: Let's talk about your time at UCSB. Did you have a mentor and how did he or she impact you?

A: During that time period, naturally, I really tried to study as quickly as possible to jump into industry, and that was the master's program. I remember when I joined the program, UCSB changed the program - all the master's degrees needed to go through the comprehension test. So, I joined UC Santa Barbara master's degree program in the fall of 1983, but I think I finished all of my credits in the summer of 1984. During that time, the semiconductor industry was not good, but I was lucky to get a few interviews along the east coast and west coast and got probably more than twenty different offers. I jumped into the market and started to work by December of 1984. I came back to the school around June or May of 1985 to go through the comprehension test to get my master's degree.

I remember the two professors that I really liked, one is Dr. Butler, the other is Dr. Howard, they're probably both no longer at UCSB, but they provided a lot of inspiration in terms of how to study a topic and how you can see something through a new angle. So those are the two professors of whom I have a really deep impression.

Q: Can you recall a pivotal moment that you had at UCSB that made an impact on your career?

A: I remember one of the best things from the program at UC Santa Barbara was that they provided a realistic course that allowed you to make a real silicon and go through the full process of testing, the full coverage, so it was very practical and gave you a much deeper knowledge. You could understand the process, not just the paper, and you could really design something that you like. That is something that I really liked.

Q: Why do you think the ECE Department is successful in training students for success?

A: I checked with my classmates, who also graduated later, but everybody got a pretty good job, which means that Santa Barbara and the Electrical and Computer Engineering Department is very effective. It really helps you develop into a person who's not just a graduate. You can learn something very solid which will link with industry very well. So even though I studied a very short period of time, the program gave me sufficient knowledge and a strong background to jump into the job market.

Q: As an alumnus of UCSB, how have you given back and why do you think that it's an important act to do?

A: To me, I got something from the school, and I like to give back but I also like to help the young generation, not just UCSB. I think that every person has a dream, a vision and a mission. Everybody has different capabilities. If I can help the younger generation and if I can make the school better I'm happy to do it.

Q: What advice do you have for the next generation of electrical and computer engineers?

A: For the younger generation, you better know what you like to do and have determination to go for it. Don't hesitate. There may be some challenges, but settle your hesitation and go do it. I believe that most people will be successful if they really have determination and work hard. The younger generation has many different opportunities, but because they have so many opportunities, sometimes they can lose their focus because they have so many choices. If you really want to be successful, you have to focus your determination and become an expert in your area.

Q: What about your professional career makes you the most proud?

A: We've become the largest controller maker in the world. We do business with all of the largest, top-tier world leaders, all of the NAND makers, for Intel, Samsung, SK Hynix, Micron, Western Digital, Kioxia in China, and Rising Star One TC. We work with many different consumer-based companies, such as Google and Amazon. We have all the PC makers, Lenovo, Dell, HP, Asus, and Acer. We have all of the major automotive makers and business with Tesla, Waymo, Toyota, Honda, Audi, you name it, and all of the smartphones except for Apple. We have a very broad customer base in the world from industrial to consumer electrics, for automotive, to some even products selling S35 today. It's through the engagement with top-tier, world-class customers you can learn, and it makes the job more exciting. By becoming more exciting, we attract people who make the company stronger and better every day, which in turn makes our products better to influence our industry and become more meaningful for our customers.

Q: How proud are you to be a graduate of UCSB's ECE program?

A: I'm proud that I graduated from UC Santa Barbara. It really gave me my first start in the U.S. It also gave me a strong foundation to enter into industry and I really appreciate it. I'd like to give back to the younger generation at the school and hopefully I can invite others to make an impact.

Wallace Kou, president and CEO of Silicon Motion

Last March, Silicon Motion sponsored the National Taiwan University Hospital's project to build an "intelligent" operating room by purchasing clinical information systems and equipment. Kou (right) is pictured with Dr. Chong-Jen Yu, superintendent of the National Taiwan University Hospital's Hsin-Chu Branch

Wallace Kou at Silicon Motion headquarters

For an extended video interview, please visit:
https://www.ece.ucsb.edu/spotlights/wallace-kou

CAPSTONE 2022

COMPUTER ENGINEERING

Last year, computer engineering students completed eight Capstone projects that exhibited impressive applications of new technologies to solve real-world problems. Team Scrapsort and team Spot On developed systems that implement deep neural networks for low-power image classification on the edge to solve the issues of recyclable sorting and parking space monitoring respectively. Team Aerobot created an impressive reconnaissance system that makes use of ultra-wideband communication technology for high bandwidth communication that is uninhibited by environmental obstacles. Teams ADA and GEM used the Lora communication standard for long-range communication to design efficient systems that can locate high impulse sounds and provide ecological monitoring over large areas. Teams Opto3D and CUDA developed medical devices to make eye surgery safer and provide first responders with a portable device that can diagnose a life-threatening blood condition common in physical trauma patients. Lastly, Project Portunus created a device that allows users to interact with their car wirelessly through their phone and access diagnostic information.

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Networked Control Laboratory
Hawkes Lab Department of Mechanical Engineering
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UCSB
Allthenticate
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HGH USA
International Foundation for Telemetering IFT Founded in 1964
BIOMIMETIC CIRCUITS & NANOSYSTEMS GROUP

1st PLACE: **SCRAPSORT**

SPONSORS: ANALOG DEVICES & IFT

Team:

Geffen Cooper

Bethany Long

Kat Copeland

Tyler Ekaireb

Vincent Benenati

"Scrapsort is a mechatronic system designed to sort recyclables at the edge. It aims to provide an efficient and inexpensive solution to the growing problem of waste. At the heart of Scrapsort lies an ultra-low-power microcontroller, the MAX78000, which includes a hardware accelerator for convolutional neural networks (CNNs). Scrapsort implements a lean machine learning model that can identify and categorize various recyclable materials, such as glass bottles and aluminum cans, while in motion on a conveyor belt. As the items travel down the conveyor, a series of pneumatic cylinders sort the recyclables into storage bins. Simultaneously, a robotic arm leverages a pneumatic suction cup to separate more valuable recyclables from the process stream. Scrapsort is designed to frontload the task of categorizing waste, so that it can be processed more efficiently and salvaged to the fullest extent possible."
website: https://sites.google.com/view/scrapsort/

ELECTRICAL ENGINEERING

Last year, electrical engineering students completed fourteen Capstone projects. Ten of these projects were composed solely of EE students, and the remaining four were multidisciplinary projects in which EE, ME, and art students collaborated. Of the EE projects, three focused on machine learning models, four on control systems, and three on signal processing. The most successful teams created products that met all design specifications and demonstrated excellent engineering analysis: team DropVision designed an improved approach to modeling tin droplets in an extreme ultraviolet lithography system through computer vision with an emphasis on speed and accuracy; team MPL implemented a maskless lithography system with the ability to print circuit boards without the limitation of an expensive photomask, and team Mimmo developed a novel synchronized radar system to accurately detect hidden moving objects using millimeter-wave radar. Successful multidisciplinary teams also demonstrated excellent communication and organizational skills: Spyglass built a self-stabilizing mast camera to significantly improve visibility on sailboats where large sails may obstruct vision.

NAVSEA NAVAL SEA SYSTEMS COMMAND · Alcon · SLAB スラブ · Arthrex · CACI EVER VIGILANT · NORTHROP GRUMMAN · AV AeroVironment · Lab D4H · CNSI CALIFORNIA NANOSYSTEMS INSTITUTE · Wireless Communication and Sensornets Laboratory

1ST PLACE: **MIMMO**

SPONSORS: MADHOW & BUCKWALTER LABS

Team:

William He

Justin Kim

Yang Liu

Shaan Sandhu

Ethan Sifferman

"Mimmo is pushing the boundaries in self-driving automative radar applications with data fusion and wireless synchronization between independent radars nodes. Our research in cross-radar signals and digital signal processing will give rise to distributed radar networks, which can form wholistic field of views even in complex environments with line of sight obstructions. This technology will greatly reduce the safety risks currently present with self-driving vehicles and give future radar system designers a new sensing platform for innovation."

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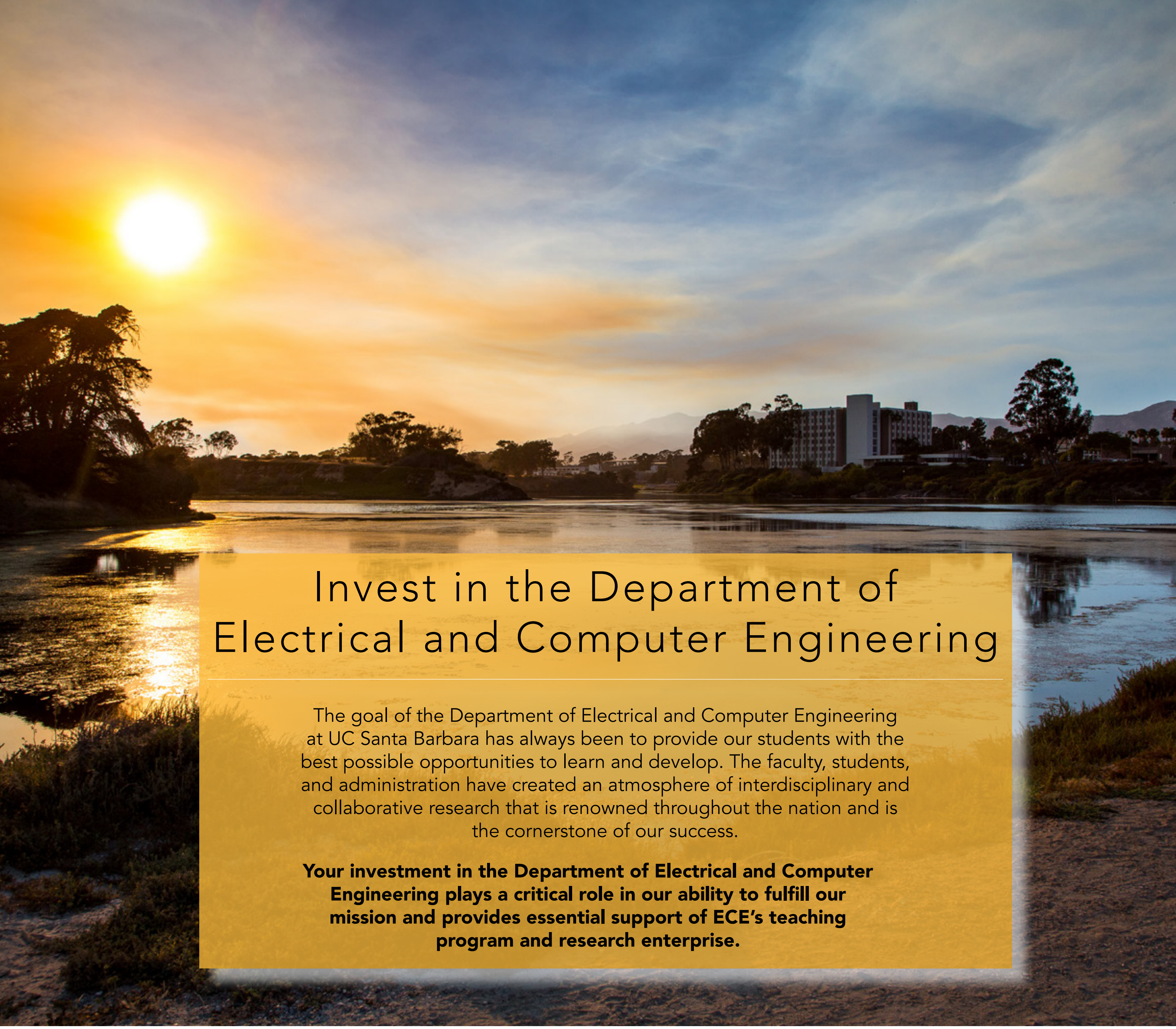

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The goal of the Department of Electrical and Computer Engineering at UC Santa Barbara has always been to provide our students with the best possible opportunities to learn and develop. The faculty, students, and administration have created an atmosphere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

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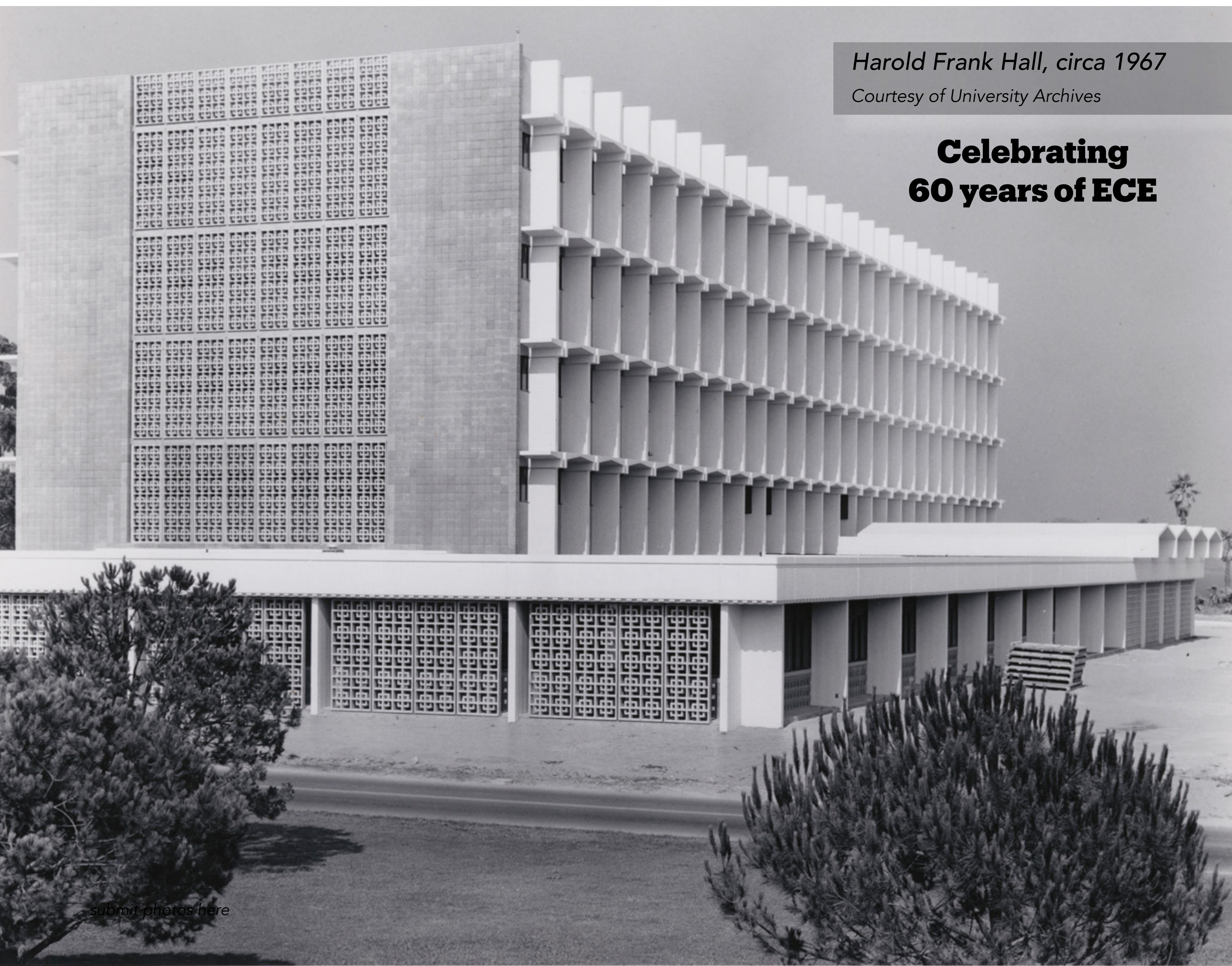
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