FALL 2018

ELECTRICAL AND COMPUTER ENGINEERING

UNIVERSITY OF WISCONSIN-MADISON

NEW FACULTY STRENGTHEN, BROADEN ECE EXPERTISE

CHAIR'S MESSAGE

It's my distinct pleasure to write this message, my first as ECE department chair. I feel quite fortunate to have been a part of this outstanding ECE department for the past 20 years, and I'm honored to be serving in this new departmental leadership role. I look forward to building upon our long tradition of excellence in educating and inspiring future leaders and in improving the world through our research advances. Let me take this opportunity to express my gratitude to our previous chair, John Booske, for serving our department so faithfully for nine years. He is on a well-deserved sabbatical for the 2018-2019 academic year.

As I write this letter, we're well into the fall semester on campus. The leaves have fallen, there's a chill in the air, and we've wrapped up our industrial advisory board meeting and our annual Homecoming Weekend Engineer's Day Celebration. We had a great time celebrating our distinguished alumni at the annual banquet. Be sure to read about our distinguished achievement award and early career award winners inside this issue.

It was an eventful summer, with several exciting announcements for ECE and the College of Engineering. We're thrilled to announce a new $100 million partnership with Foxconn, the global leader in electronics manufacturing, which includes funding to help establish a new interdisciplinary research facility on the College of Engineering campus here at the UW-Madison. Several ECE faculty members were involved in the talks with Foxconn, and we're looking forward to many cross-disciplinary research opportunities that will emerge from this partnership.

Additionally, we welcomed two new ECE faculty members, Bhuvana Krishnaswamy and Line Roald. They bring creative and innovative cross-disciplinary perspectives to their research, and they both were drawn to ECE, in part, because of the department's highly collaborative culture. I'm also delighted to note that with their addition, the percentage of women faculty in our department stands out as one of the highest in the nation. Read more about our two new hires inside the newsletter!

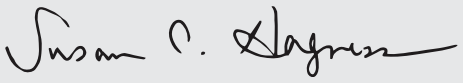
We're expecting to grow our faculty even further by the end of this academic year. We are co-leading a cross-campus cluster hiring initiative in quantum science and engineering. We also have ongoing ECE and cross-college hiring initiatives aimed at adding to our department's world-renowned expertise in the fields of mobile computing systems, microgrids and sustainable electrical energy, electric machines and power electronics, machine learning and artificial intelligence, and sensors and sensing.

That expertise continues to earn our department well-deserved recognition nationally and internationally. Read more inside this issue about some of the amazing research advances that our ECE faculty and students are making—everything from robust and efficient machine learning to renewable energy to infrared camouflage—and their boundary-pushing research is helping make the world a better place.

This fall we welcomed a second cohort of students in our accelerated MS in Electrical Engineering degree program in Signal Processing and Machine Learning. The combined focus on the mathematical foundations of data science and engineering and their application to real-world problems prepares our graduates to immediately contribute to the workforce and solve even the most challenging data science and engineering questions. We are also rolling out a brand-new accelerated Professional MS in Electrical Engineering to students who will start in Fall 2019.

Great things are in store for this year and beyond, and I look forward to keeping in touch with you. Drop me a note any time at: susan.hagness@wisc.edu

ON, WISCONSIN!



Susan Hagness
Philip Dunham Reed Professor and Chair
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Investment from Foxconn initiates major new partnership

Foxconn Technology Group and its Chairman and Founder, Terry Gou, announced plans to invest $100 million in engineering and innovation research at the University of Wisconsin-Madison, while also creating the framework for a science and technology institute that will collaborate closely with the company's facilities in southeast Wisconsin.

The Foxconn investment will include funding to help establish a new interdisciplinary research facility for the College of Engineering on the UW-Madison campus.

The agreements formalize Foxconn's commitment to activities such as research, recruiting, creating opportunities for internships and hands-on work in campus labs. In addition, the planned Engineering building will enhance the college's capabilities and allow it to be an active partner in research.

"At Foxconn, we see our role as not only being a major investor in Wisconsin, but also a long-term partner to the local community. This includes promoting a vibrant environment that nurtures and enables Wisconsin's talented workforce, allowing them to tap the immense opportunities that Wisconn Valley has to offer," said Gou, founder and CEO of Foxconn Technology Group.

Line Roald

It ain't easy going green.

The energy infrastructure that powers our world was largely built to transmit electricity from traditional sources like coal-fired or nuclear power plants. The transition to renewable energy, like solar and wind power, however, will require big changes to the grid to ensure reliable and secure electricity.

Line Roald, a new assistant professor, is finding solutions to keep electricity flowing without interruptions so that our power can be green.

"I do what I do because I want to contribute to a more sustainable world with an energy system that still delivers power reliably," says Roald, who joined the ECE in fall 2018.

Power from renewable sources presents a challenge for energy system operators because the amount of electricity generated from a solar installation or a wind farm can vary wildly depending on the time of day or weather conditions. That uncertainty makes it necessary to totally rethink how electricity flows through the grid and into people's homes.

To devise strategies for switching from traditional power to sustainable sources, Roald draws from the field of optimization. Her approach hinges on representing all aspects of a power grid with mathematical equations, and then solving them to reveal strategies for delivering reliable and cost-effective electricity.

That's no easy feat, given the extreme complexity of an electric grid and the importance of keeping the lights on in homes, businesses, hospitals and many others.

"We all use electricity all the time every day," says Roald. "But the only time most people think about power is when it is not there."

Roald's work aims to avoid leaving consumers "powerless," while empowering system operators to generate electricity from more sustainable sources. It's an endeavor that is taking on even more urgency as extreme weather events become more common; the grid not only needs to deliver electricity, but it also must withstand an unpredictable climate.

Roald's work aims to avoid leaving consumers "powerless," while empowering system operators to generate electricity from more sustainable sources.

Roald has firsthand experience helping countries make the switch to renewable energy. During her PhD research at ETH Zurich in Switzerland, which she completed in 2016, Roald worked with system operators in Germany to help ease the transition away from nuclear power plants—almost one quarter of the country's energy-generation capacity—in favor of solar and wind.

"Reliability is a big societal question," says Roald. "Power and energy security are really important."

Although Roald's research now encompasses the energy grid as a whole, she got her start working on individual power generation components. After graduating with a bachelor's degree in mechanical engineering from ETH Zurich in 2010, she designed systems for wave power and floating offshore wind turbines during her master's degree studies at the same institution, which she completed in 2012.

That work on renewable energy sources sparked Roald to start thinking about the bigger picture—as in how electricity makes its way from a windmill to the outlet on a wall. Those questions motivated her to pursue a PhD at ETH Zurich and subsequent postdoctoral research at Los Alamos National Laboratory, in New Mexico.

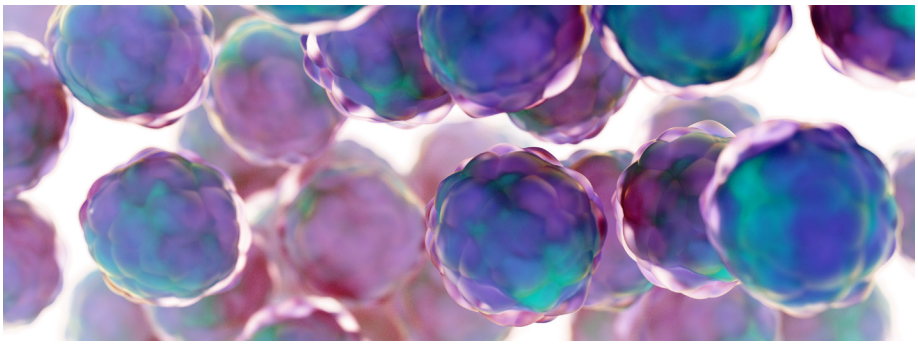
Now at UW-Madison, Roald is excited to join the long lineage of power engineering excellence in the electrical and computer engineering department as well as the vibrant community of optimization researchers on campus. She still maintains contact with system operators in Europe, and is looking forward to establishing similar relationships with people in the U.S. power industry.

Roald arrived in Madison immediately before a record-breaking rainstorm in August 2018 that left much of the city flooded for several weeks. For Roald, that severe weather event further underscored the importance of pursuing renewable power.

And although an unexpected deluge wasn't quite the welcome she expected, Roald made the best of a soggy situation.

"I sandbagged my house, and I got to know all my neighbors," says Roald. "People here in Madison are super friendly."

Bhuvana Krishnaswamy



What does a cell phone have in common with a single-celled bacterium?

In terms of cell-to-cell communications, the same theories and algorithms that underpin wireless networks can also describe how microbes interact.

"Bacteria communicate using chemicals," says Bhuvana Krishnaswamy, who joined ECE as an assistant professor in fall 2018. "I apply electrical engineering principles to make that information transfer more efficient."

And by applying those principles, Krishnaswamy aims to create living sensors made from networks of bacterial cells.

"In nature, bacteria have evolved to sense their environment," says Krishnaswamy. "We can leverage that to detect tiny amounts of potentially dangerous pathogens."

Such living sensors might someday be able to alert doctors if an otherwise clean-looking instrument is, in fact, contaminated with nasty microbes like methicillin-resistant Staphylococcus aureus (MRSA), which can cause lethal infections.

"By its nature, my research requires expertise from a variety of disciplines and willingness to work together. UW-Madison was one of the most collaborative places I visited. It was also the most receptive to improving the existing collaborative, interdisciplinary environment."

"Most surfaces are covered with harmless bacteria, but the tiniest amount of MRSA can be fatal for a patient with a weakened immune system," says Krishnaswamy.

And no devices capable of quickly sensing small amounts of dangerous microbes currently exist.

Electronic sensors constantly require a power source, and even the smallest batteries are orders of magnitude larger than bacteria. To create a pathogen detection system that never needs recharging, Krishnaswamy turned to living things.

Krishnaswamy plans to genetically engineer harmless bacteria so that they react to pathogens. The concept is straightforward: Sensor microbes that detect danger will send out chemical signals that induce receiver bacteria to produce an alarm. That alarm could be a burst of light, a change of color, or even something that attacks invasive microbes.

The way those chemical alerts travel between bacteria is similar to how information flows across a wireless network: Individual nodes of cells broadcast signals that are picked up by distant receivers. And those signals need to come through clearly amidst a noisy and complicated environment. By applying algorithms from communication theory, Krishnaswamy tweaks the properties of the signals as well as the characteristics of the receivers to make sure that messages transmit faithfully.

Eventually, she hopes to apply the concept directly to human health: She envisions creating a powerful and smart probiotic composed of several bacterial communities that patrol the human body, sniffing out and fighting off invading pathogens.

It's a project that blends synthetic biology with fluid dynamics and communication theory, and that interdisciplinary spirit is part of what enticed Krishnaswamy to join the faculty at UW-Madison.

"By its nature, my research requires expertise from a variety of disciplines and willingness to work together. UW-Madison was one of the most collaborative places I visited. It was also the most receptive to improving the existing collaborative, interdisciplinary environment," says Krishnaswamy.

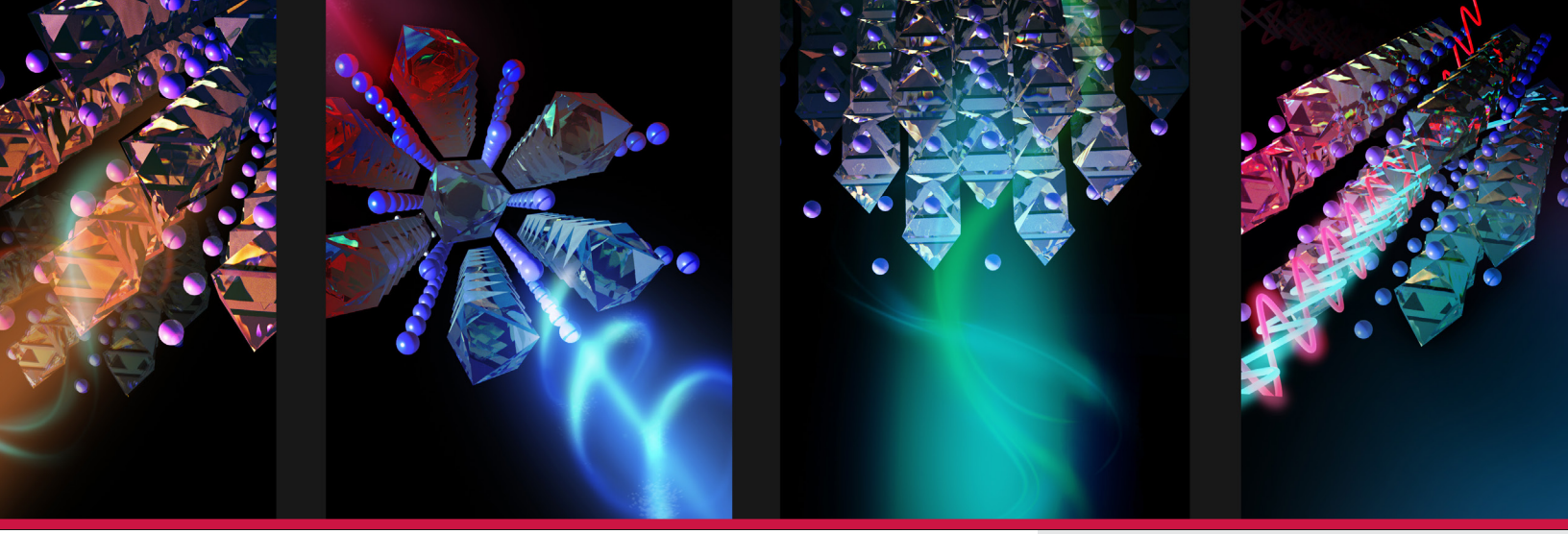
Collaboration was central to Krishnaswamy's graduate training at the Georgia Institute of Technology, where she received a master's degree in 2013 and completed her PhD in 2018. There, she worked with mechanical engineers and biological engineers to optimize communications among bacteria growing within a microfluidic device.

She'll build on that work here at UW-Madison, and take steps toward integrating living sensor systems with electrical outputs.

Krishnaswamy recognizes that her research is unique for the ECE department—few ECE professors work on communication networks composed of living devices—but similar questions arise for other systems where size and battery life are at a premium, such as wearable technologies.

And Krishnaswamy always keeps an open mind to exploring new avenues of research.

"I really value discussions with people from different backgrounds," she says. "Diversity of perspectives gives me the excitement to learn something way out of my comfort zone."



A BRIGHT FUTURE: NEW MATERIAL SMASHES LIGHT-SPLITTING RECORDS

Place a chunk of the clear mineral called Iceland spar on top of an image and suddenly you'll see double, thanks to a phenomenon called double refraction—a result of the material's optical anisotropy. Beyond just a nifty trick, materials with optical anisotropy are vital for a variety of devices such as lasers, LCD screens, lens filters or microscopes.

Now, a new crystal has a higher degree of optical anisotropy than all other solid substances on earth—especially for light in the infrared region of the spectrum.

"The optical anisotropy is enormous, making the material promising for a range of optics applications" says Assistant Professor Mikhail Kats.

One especially promising use for the new crystal could be imaging and other types of remote sensing using the mid-infrared transparency window—an especially important range of wavelengths that penetrate Earth's atmosphere.

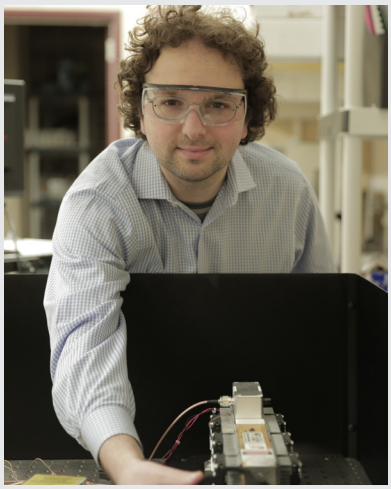
"This class of materials and this approach has a lot of potential," says Jayakanth Ravichandran, an assistant professor of chemical engineering and materials science and electrical engineering-electrophysics at USC, and a collaborator on the project. "We designed the material, made it, and saw a huge effect."

The new crystal has roughly 10 times greater optical birefringence—a metric of anisotropy—for mid-infrared light than has ever been measured before. That spectacular light-splitting ability comes from a unique molecular structure consisting of long chains of atoms arranged in parallel rows.

The new material might also be useful in energy-harvesting photovoltaic cells or light-emitting diodes. In the future, the researchers plan to explore other properties of the new material as they also work to develop strategies to synthesize it in large quantities.

The scientists are filing a patent on the material through USC and the Wisconsin Alumni Research Foundation at UW-Madison.

Read more: www.engr.wisc.edu/bright-future-new-material-smashes-light-splitting-records/



Kats named to ASEE *Prism* 20 Under 40

In recognition of his excellent teaching and pioneering work creating novel materials that bend and reshape light, the American Society for Engineering Education (ASEE) identified Assistant Professor Mikhail Kats as one of America's 20 most highly promising investigators under the age of 40. Published each year in ASEE's flagship magazine, *Prism*, the '20 under 40' list recognizes young engineers with a demonstrated talent for instruction who conduct research with real-world implications.

COULD COMPUTERS HELP CLOSE PARTISAN DIVIDES?

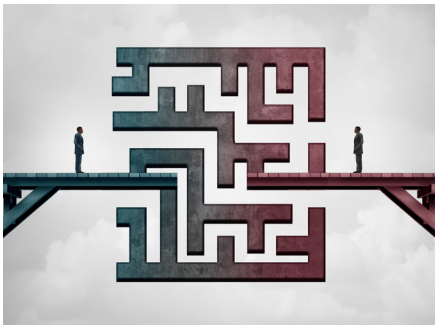
Engineers at UW-Madison are using computers in new ways to develop a comprehensive picture of how people communicate about politics, and how those conversations can be shaped by media, social networks and personal interactions.

The researchers are harnessing the power of machine learning, in which UW-Madison is a leading innovator, to detect how people of opposite political persuasions assign different meanings to the same words.

For example, the word "regulation" can carry substantially different connotations—"helpful and necessary" or "onerous and invasive"—for liberals and conservatives. While those sentiments might seem intuitive, it's difficult to rigorously define and quantify exactly how people assign meanings to words.

Machine learning offers a solution to that problem by transforming words into geometric concepts called vectors and using mathematical operations to make comparisons.

"Vectors show you something about the words," says Professor William Sethares, a collaborator on the project. "Simple things like synonyms will have similar vectors, and vectors for analogous words will have the same relationships to each other."



After comparing vectors from roughly 2,000 tweets posted by liberals, conservatives and nonpartisans, the researchers identified the top 10 words with different usages among political ideologies, including "politician," "government" and "environment."

Revealing those differences required a new computational approach, developed by Sethares and graduate student Prathusha Sarma.

What their computer analysis finds, the researchers hope, could help bridge the divide between people on either side of the political aisle.

Read more: www.engr.wisc.edu/computers-help-close-partisan-divides/

Making machine learning more robust

Underneath the virtual surface, much remains mysterious in the realm of machine learning, where systems attempt to mimic the remarkable way humans learn.

Current machine learning capabilities aren't up to the task for handling highly complex, rapidly changing, or uncertain environments, and artificial intelligence can easily be tricked by false information from a clever adversary—critical situations for national defense.

In an effort to build the next generation of machine-learning methods, the Air Force Office of Scientific Research and the Air Force Research Laboratory have awarded $5 million to establish a university center of excellence at UW-Madison.

Called the Machines, Algorithms and Data Lab (MADLab), the center is led by Robert Nowak, the McFarland-Bascom Professor.

Center collaborators also include UW-Madison electrical and computer engineers Mikko Lipasti and Dimitris Papailiopoulos; Jerry Zhu and Yingyu Liang from the UW-Madison Department of Computer Sciences; and Greg Shakhnarovich and Karen Livescu from the Toyota Technological Institute at Chicago.

Read more: www.engr.wisc.edu/making-machine-learning-robust/

'Stealth sheet' hides hot objects from prying infrared eyes

Infrared cameras are the heat-sensing eyes that help drones find their targets, even in the dead of night or through heavy fog.

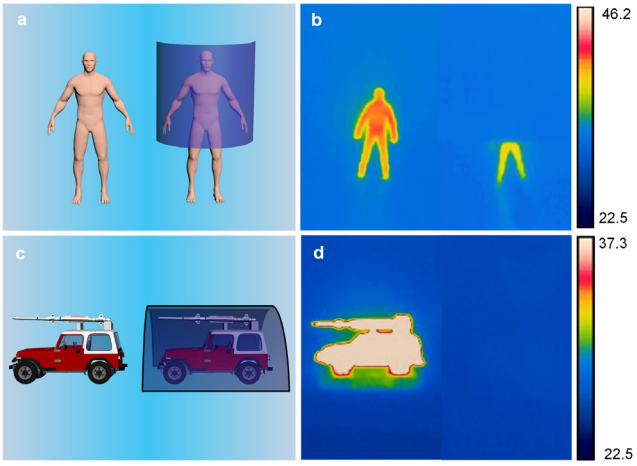
Hiding from such detectors could become much easier, thanks to a new cloaking material that renders objects—and people—practically invisible.

"What we have shown is an ultrathin stealth 'sheet.' Right now, what people have is much heavier metal armor or thermal blankets," says Hongrui Jiang, the Lynn H. Matthias Professor and Vilas Distinguished Achievement Professor.

Warm objects like human bodies or tank engines emit heat as infrared light, and the new stealth sheet offers substantial improvements over other heat-masking technologies.

Measuring less than one millimeter wide—roughly the thickness of 10 paper pages—the thin sheet absorbs approximately 94 percent of the infrared light it encounters.

Importantly, the stealth material can strongly absorb light in the so-called mid- and long-wavelength infrared range, which is the type of light emitted by objects at approximately human body temperature.



Read more: www.engr.wisc.edu/stealth-sheet-hides-hot-objects-prying-infrared-eyes/

HAVE YOU HEARD? ANIMAL-INSPIRED SENSORS CAN DETECT DISTANT OBJECTS

Drawing inspiration from the directional hearing abilities of geckos, a multi-institution team led by UW-Madison engineers has created first-of-their-kind high-resolution sensors that can deduce the angle of incoming light beams.

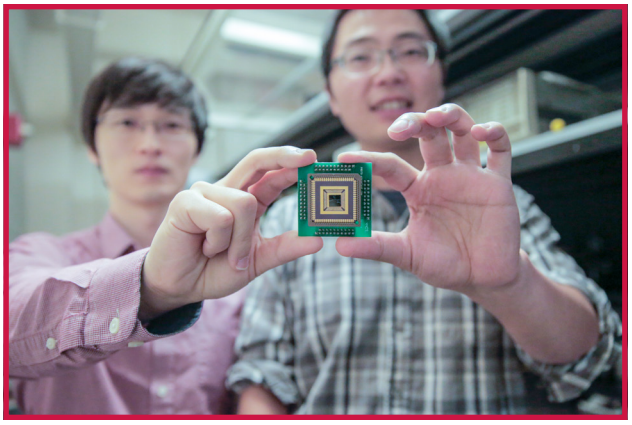
It's an advance that could help autonomous vehicles navigate roads or unlock a whole host of capabilities for cameras and telescopes by giving their photodetectors access to information about the direction of light.

"Conventional photodetectors can only detect the intensity of light, but there are many more properties," says Soongyu Yi, a PhD student, who works in Assistant Professor Zongfu Yu's lab. Yi was first author on a paper describing the new devices, published Oct. 29, 2018, in the journal Nature Nanotechnology.

With information about the angle of incoming light, cameras can more accurately measure the distance to objects in an image.

Other groups have attempted to create photodetectors that can glean information about depth, but those previous attempts suffered from low resolution.

Drawing inspiration from geckos, a multi-institution team led by engineers at UW-Madison created photodetectors that resolved pixels smaller than the wavelength of light.



Soongyu Yi (left) and Ming Zhou (right) holding a gecko-inspired photodetector that senses the angle of incoming light.

Yi and colleagues were able to create high-resolution photodetectors that resolved pixels smaller than the wavelength of light. To do so, they turned their eyes to the ears of small animals like geckos, crickets and mice.

Those tiny critters share a unique ability called directional hearing.

Big animals like rabbits or people—those with heads wider than the wavelength of sound—perceive a tiny time delay between when each of their individual ears picks up a noise. That allows them to determine the direction from which the sound originated.

Small animals can't rely on that time-lag. Instead, many creatures—geckos and crickets included—have a tunnel inside their head that links their two ears. Sound waves traveling back and forth through the tunnel create a new signal that allows the animals to determine the sound's direction. It's an adaptation found in more than 15,000 species.

A team of engineers has created high-resolution sensors that can deduce the angle of incoming light beams—an advance that could help autonomous vehicles navigate roads or unlock a whole host of capabilities for cameras and telescopes.

The researchers used a similar strategy, creating special photodetectors consisting of two tiny, optically linked wires.

"Each wire absorbs and scatters light, and the scattered light interacts with the other wire," says Ming Zhou, a UW-Madison electrical and computer engineering PhD student who was second author on the paper.

Just like water ripples bouncing between two vertical pilings in a lake or sound traveling through the tunnel in a gecko's skull, light waves scatter between the two nanowires in the new photodetectors. Combining that scattered light with signals from each individual nanowire allows the researchers to calculate the light's direction.

"It's two photodetectors working together, electrically separate from each other, but optically coupled. That gives us the physics," says Zhou.

Other members of the team include Zongfu Yu, the Dugald C. Jackson Assistant Professor of electrical and computer engineering at UW-Madison, Nader Behdad, Professor and Harvey D. Spangler Faculty Scholar of electrical and computer engineering at UW-Madison, and several researchers at Stanford University.

Read more: www.engr.wisc.edu/heard-animal-inspired-sensors-can-detect-distant-objects/

2018 ENGINEERS' DAY AWARD RECIPIENTS

Each year, the College of Engineering recognizes outstanding alumni during Engineers' Day—a celebration of engineers, held on Homecoming weekend. The recipients of the annual College of Engineering Distinguished Achievement Awards and Early Career Achievement Award illustrate the vast impact Badger engineers have across multiple fields and around the world. Be sure to go to the indicated web addresses for interviews with our award recipients about everything from their memories as students to their careers and hobbies.

Wendy Harris
Distinguished Achievement Award

COO and GM, Commercial Operations, GE Healthcare
BSECE '90, MBA '99, UW-Madison

Each year, the College of Engineering recognizes outstanding alumni during Engineers' Day—a celebration of engineers, held on Homecoming weekend. This year, one of the 2018 Distinguished Achievement Awards went to Wendy Harris (BSECE '90, MBA '99), who is now Chief Operating Officer and General Manager, Commercial Operations, at GE Healthcare.

We honored Wendy for her industry leadership in healthcare technologies, workforce diversification, and women's health issues.

Wendy is passionate about human health. During her 28-year career with GE Healthcare, she has been a member of the executive team for nearly two decades, making a difference in roles throughout the country that include service, sales, marketing and operations.

Recently, we chatted with her about everything from her memories as a student at UW-Madison to her career and hobbies. Here are her responses to some of our questions.

Of what professional accomplishment are you most proud?

We just launched GE Healthcare as a separate stand-alone company. In the past we were part of GE as a large industrial company. While that was great, it also sometimes restricted our ability to grow in the healthcare space. I really believe in GE Healthcare and our ability to shape our own destiny and run a very large "startup" company. I have been a part of growing GE Healthcare over my 28-year career; I have grown several businesses and started new businesses at GE Healthcare. I have seen firsthand how our technology saves lives. I ran our training organization for seven years and was responsible for making sure that doctors and nurses know how to use our great GE technology. Technology is only as good as you can train people to use it.

Why did you choose engineering?

I was always interested in math and science and how things work. When I was young, I would build things. My dad was a builder, and my mom was a UW graduate. I really enjoy structural concepts, engineering and geometry, so I think engineering was a natural fit for the way I could apply math and science as practical applications in the world.

What was your favorite engineering class?

I met my husband in Statics and Strength of Materials as a sophomore here at UW, so that has to be my favorite class. He's a chemical engineer from UW-Madison and that happened to be one of the classes that all engineering disciplines take. That class was a great overview of all the engineering disciplines. I also like the fact that it brought a lot of different engineering disciplines together and you got to learn what different people were interested in. I also happened to be really good at it!

How did your experience in the College of Engineering shape your career?

It really pushed me to be competitive and make sure that I bring whatever I can to not only understand the material but do better than my peers. I think that was a good lesson for me; the world is a competitive place. Just being exposed to a lot of people at Madison who are really smart people was a good wake-up call for a small-town girl. It was a way to make sure that you're grounded in life and the caliber of talent in this world: You've got to work at it, you've got to be on top of your game at all times.

Who has played the greatest role in your achievements?

I could probably name professors and teachers and a lot of people at GE Healthcare, but I would also say my husband has been very supportive. Without him, I really could not have accomplished what I have done, particularly with our four children. So having four children and being an executive—it's not always easy to balance all of those things. He also supported me through breast cancer treatment and through every new career decision and move.

Is there anything else that you would like us to know?

I come from a strong UW Badger family. My mom was one of the first women in the business honor society at UW. My husband and I both are engineers from UW and were very well prepared for success. My daughter is at UW-Madison as a biology major, hopefully going to be a med student. She does research in labs at UW Hospital, so I get to go back and see her be successful at UW-Madison. My second child ended up going to the Milwaukee School of Engineering, but at least we got an engineer! We definitely have the science and math push in our family, and two more children—one is a sophomore in high school, and one is an 8th grader—so hopefully we'll get another Badger or two out of the last two. I try to brainwash them early! I love UW and am honored to be a part of the UW alumni, the ECE alumni board and one of the recipients of this award.

2018 ENGINEERS' DAY AWARD RECIPIENTS

Early Career Achievement Awards

Justin Beck

Chief Executive Officer, PerBlue
BSCMPE '09, BSCS '09, UW-Madison

We honored Justin for his leadership in nurturing the Wisconsin entrepreneurial ecosystem, the state's economic development, and as an exemplary demonstrator of collaborative engineering success.

Read the Q&A: www.engr.wisc.edu/justin-beck-2018-early-career-award-recipient/

Andrew Hanson

Chief Technology Officer, PerBlue
BSCMPE '09, BSCS '09, UW-Madison

We honored Andrew for his leadership in nurturing the Wisconsin entrepreneurial ecosystem, the state's economic development, and as an exemplary demonstrator of collaborative engineering success.

Read the Q&A: www.engr.wisc.edu/andrew-hanson-2018-early-career-award-recipient/

Forrest Woolworth

Chief Operating Officer, PerBlue
BSCMPE '09, BSCS '09, UW-Madison

We honored Forrest for his leadership in nurturing the Wisconsin entrepreneurial ecosystem, the state's economic development, and as an exemplary demonstrator of collaborative engineering success.

Read the Q&A: www.engr.wisc.edu/forrest-woolworth-2018-early-career-award-recipient/

STUDENT NEWS

Rhodes scholar: Undergrad elevates education in Colorado energy internship

Noah Rhodes hasn't spent much time in Wisconsin during 2018.

The senior spent most of January, 2018, in Guatemala, working on a service project for Engineers Without Borders. Then, merely four days after returning from a summer study abroad program in Copenhagen, he packed up his car and drove to Golden, Colorado, for a 16-week-long research internship at the Department of Energy National Renewable Energy Laboratory, or NREL, a state-of-the-art facility tucked into the foothills of the Rocky Mountains.

For Rhodes, the inconvenience of moving—twice—was well worth the opportunity to pursue a research project at NREL, where he works in the building and energy efficiency subgroup.

"Doing independent research has been so valuable," says Rhodes. "The experience really helped me be confident in my decision to apply to grad school next year."

Although the internship kept Rhodes busy, he found time to take full advantage of the outdoor activities Colorado has to offer. An avid cyclist, Rhodes biked a famous local route called Lookout Mountain several times per week during the early autumn. He also hiked to the summit of Mount Bierstadt and enjoyed numerous rock-climbing and camping excursions.

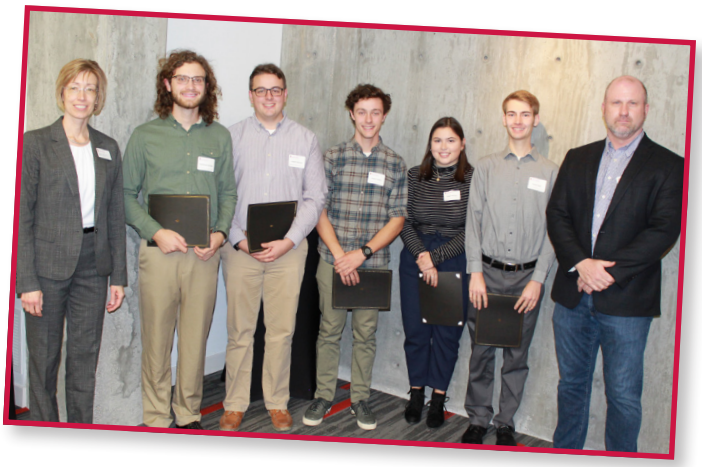
After completing his coursework requirements in fall 2019, Rhodes plans to apply to graduate school, where he hopes to continue working on power systems and renewable energy.

"Energy is a fascinating problem," says Rhodes, "It's heavy theoretical math with the opportunity to make a real difference in the world."

Read more: www.engr.wisc.edu/rhodes-scholar-undergrad-elevates-education-colorado-energy-internship/

Undergraduate scholarship night honors excellent students

At the fall undergraduate scholarship awards ceremony held Oct. 17, 2018, at Madison's Hotel RED, we recognized our outstanding students for their dedication and academic excellence. This year, we awarded 71 scholarships, totaling roughly $300,000, which is an increase of almost $100,000 compared to last year. These scholarships help our students offset educational and research expenses, allowing them to devote more energy and effort to their studies. Please join us in congratulating our distinguished scholars.



ECE alumnus Doug Dallmann (pictured above, far right) gave a new gift supporting an award in 2018. The recipient of the 2018 Dallmann scholarship was Nathaniel Zerrien (pictured, 2nd from left). Other students in this photo received other awards.

In 2018, ECE alumnus Nick Kamboj (pictured below, far right) added to his gift to expand the number of the Aston & James Publishing scholarships he supports. This year, six students received awards. The recipients (pictured below, from left to right) were Brandon Hahn, Christian Zimonick, John Gilles, Amy Sullivan, John Compas, and Michael Siem.

A gift from ECE alumnus Joe Fourness (pictured to the right, far right) continues to enable one scholarship award each year. In 2018, Zachary Zhou (pictured, 2nd from left) received the Fourness scholarship. Other students in this photo received other awards.

ECE graduate students earn national fellowships

Ray Wambold, a PhD student in Mikhail Kats' group, received a Department of Defense Science Mathematics & Research for Transformation Scholarship for Service, sponsored by the Air Force Research Laboratory. With support from the scholarship, Wambold will continue his research into monolithic semiconductor platforms to reshape infrared light, which could be used in tactical situations for directed energy or defensive countermeasures. The award provides full tuition along with a generous stipend and the opportunity for employment with the Department of Defense.

Audrey Evans, a PhD student advised by Susan Hagness, was awarded a highly competitive National Science Foundation Graduate Research Fellowship. Her winning proposal, titled "Microwave-induced thermoacoustic imaging for microwave ablation monitoring," details a new strategy for monitoring the effectiveness of a form of cancer therapy called microwave ablation in real time, which could make the treatments cheaper and more accessible to patients. The fellowship provides three years of financial support through a $34,000 annual stipend and $12,000 education allowance.

In recognition of his pioneering research on high-efficiency and high-power-density new and classical electric motors with wide bandgap device power electronic drives, Associate Professor **Bulent Sarlioglu** received the highly prestigious Nagamori Award. At the official recognition ceremony in Kyoto on Sept. 2, 2018, Sarlioglu received the award from Shigenobu Nagamori, the founder and CEO of Nidec Corp., the world's preeminent comprehensive motor manufacturer.

The National Science Foundation's Secure and Trustworthy Cyberspace program awarded Associate Professor **Azadeh Davoodi** a $468,000 grant to help protect American trade secrets as more and more companies rely on overseas foundries to manufacture computer chips. Davoodi is developing a fabrication technique called split manufacturing, where foundries that could pose security risks receive only a select portion of a computer chip's design so that the final product can be assembled later at a secure facility. Using machine learning, Davoodi will determine what components of a design are safe to share as well as create tools to confound any attempts to reverse engineer computer chips from partial instructions.

A paper coauthored by Assistant Professor **Dimitris Papailiopoulos** was among the top-10 most-accessed articles in the journal *IEEE Transactions of Information Theory*. The article, "Speeding up distributed machine learning using codes," outlines theoretical strategies for avoiding system bottlenecks on computers running distributed learning algorithms by introducing redundancy into the computation.

Assistant Professor **Laurent Lessard** was first author on one of the most frequently downloaded papers from the *Society of Industrial and Applied Mathematics Journal on Optimization*. The paper, "Analysis and design of optimization algorithms via integral quadratic constraints," describes a method to analyze iterative optimization algorithms, which he and his collaborators leverage into a new strategy to search for algorithms with the desired characteristics.

Two assistant professors played pivotal roles in organizing conferences on the topic of machine learning. **Dimitris Papailiopoulos** was co-chair for the SysML Conference, a new meeting targeting research at the interface between systems and machine learning held Feb. 15-16, 2018 in Stanford, California. Additionally, **Po-Ling Loh** co-chaired the Midwest Machine Learning Symposium, June 6-7, 2018, at the University of Chicago. Both conferences drew impressive rosters of invited speakers and submitted talks from researchers at all stages of their careers to discuss cutting-edge advances and opportunities for the future of data science.

Christopher L. Demarco, the Grainger Professor of Power Engineering, retired on June 30, 2018 after a long and distinguished career spanning more than three decades. Demarco's research focused on nonlinear stability and control theory, with particular emphasis on applications in electric power systems in order to enable the large-scale evolution of the power grid.

Professor **B Ross Barmish** is retiring as of January 2, 2019. Since joining the faculty in 1984, Barmish contributed to more than 250 publications and conference publications as well as coauthoring a seminal textbook, "New Tools for Robustness of Linear Systems." A fellow of both the IEEE and IFAC, Barmish's contributions to the theory of robustness of dynamical systems have earned him numerous accolades throughout his career.

Deep care for students motivates professors to excel at teaching

Great teachers aren't born—they're made.

And one way for professors to become great teachers is through the Madison Teaching and Learning Excellence program, a two-semester long fellowship.

"On a fundamental side, the program really helped me understand teaching," says Zongfu Yu, the Dugald C. Jackson Assistant Professor who participated in the program during the 2017-2018 academic year. "On the practical side, the program gives techniques that you can implement right away to be a more effective teacher."

Two of Yu's colleagues in ECE will follow in his footsteps in the coming years: Assistant Professor Papailiopoulos began the program in fall 2018, and Assistant Professor Eric Severson has been accepted to a 2019 cohort.

Each cohort numbers roughly eight to 12 faculty members and the application process is designed to bring together a cohort of educators who are committed to their students.

"We want to see that program participants truly care deeply about learning," says Christian Castro, assistant director of the program. "They aren't just looking for tips and tricks to let them be quicker teachers, but they have genuine concern for students."

The curriculum begins with solid foundation of educational theory before introducing classroom-specific teaching techniques.

One neuroscience-based strategy that Yu implemented into his graduate-level ECE 742 class was including more opportunities for students to engage with course material through small group discussions, quizzes or problem-solving exercises in class.

Research has shown that these and other "active learning" methodologies dramatically boost student comprehension and retention.

"My teaching has become more two-way, and I'm finding that the students are much more engaged," says Yu.

Read more: www.engr.wisc.edu/deep-care-students-motivates-professors-excel-teaching/

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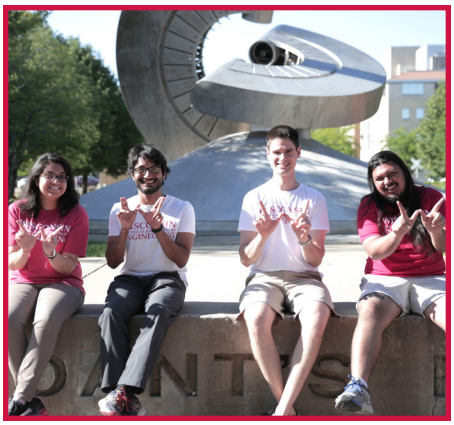
ACCELERATED PROGRAMS IN ECE OPEN UP OPPORTUNITIES

Of the 21 flexible online and accelerated masters degrees offered across all departments by the College of Engineering, two new programs are specific to ECE. Both can be completed within 16 months of rigorous work, and promise students exceptional "jump-starts" to pursue in-demand careers. These new programs differ from standard research-based masters degree plans by replacing the independent research that leads to a written thesis with an accelerated coursework schedule and opportunities for professional development or a summer practicum.

MS, Machine Learning

The Signal Processing and Machine Learning (SPML) program is intended for students with a passion for quantitative thinking, practical problem solving, computer programming, looking for to jump-start a career in data science. The 30-credit program may be completed in one calendar year, beginning in fall semester. Students will learn mathematical, scientific, and engineering principles in SPML and complete a summer practicum.



MS, Electrical Engineering, Professional

The Professional program is intended for students looking for an advanced entry into an electrical engineering career in any industry. Motivated students can complete all the 30 credits of coursework requirements for the degree in a predictable 16-month timeframe complete with professional development during the summer. Students will tailor their classes to learn mathematical, scientific, and engineering principles in their focus areas.