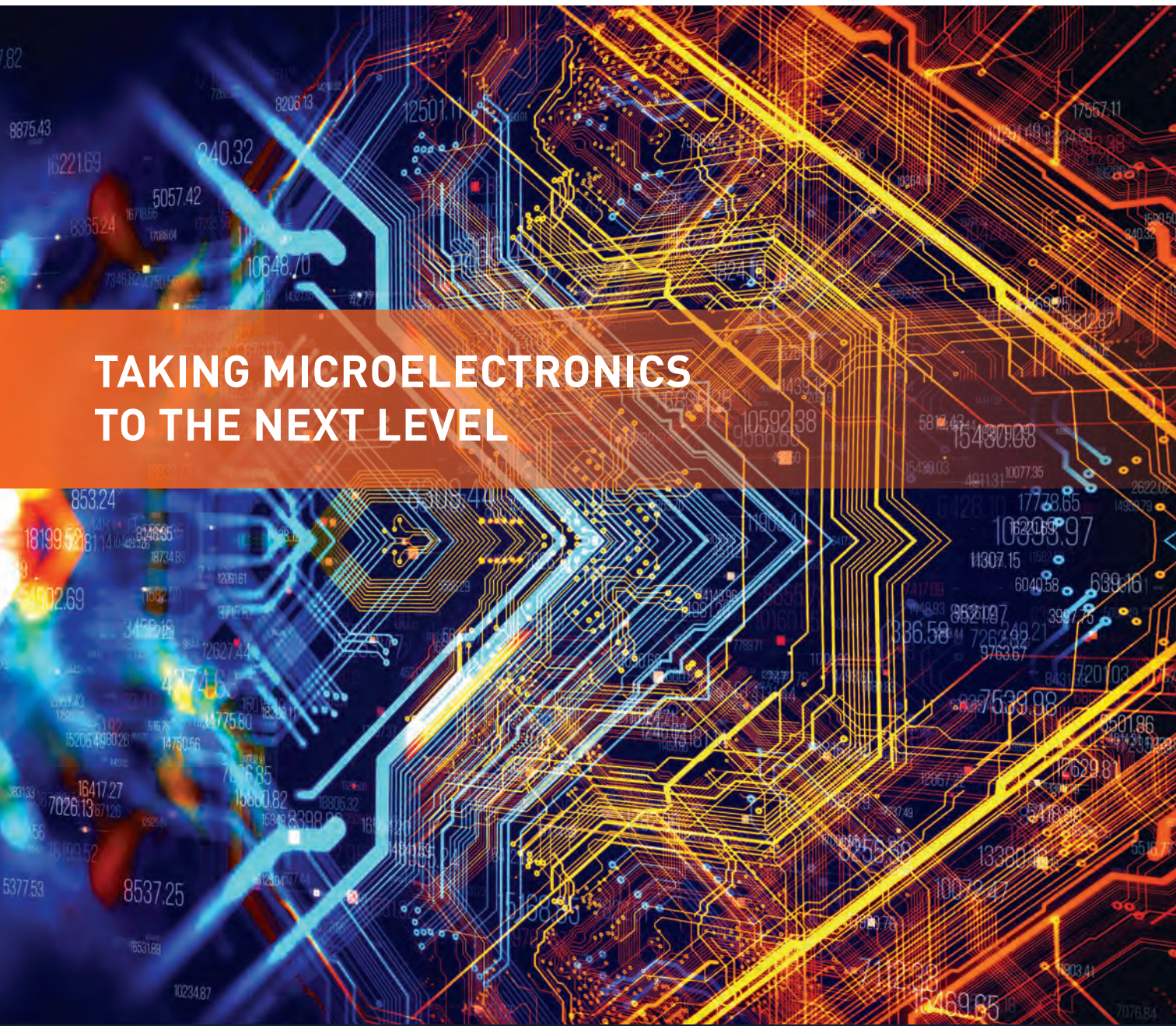
CREATING ARTIFICIAL INTELLIGENCE TOOLS STEPPING UP TO THE MICROPHONE CELEBRATING FACULTY ACCOMPLISHMENTS SITTING ATOP THE POWER RANKINGS NETWORKING WITH ALUMNI

RESONANCE

THE MAGAZINE OF ECE ILLINOIS

FALL 2018



TAKING MICROELECTRONICS TO THE NEXT LEVEL

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TOP OF MIND

I am honored and delighted to introduce this issue of *Resonance*, our department's magazine. At the end of August, Bill Sanders stepped into a new role as interim director of the Discovery Partners Institute, a new world-class innovation center led by the University of Illinois System. I am grateful for the opportunity to serve as the Acting Department Head.

Although Bill's departure was sudden and the request to me was unexpected, I accepted it because of the confidence I have in the faculty, staff, and alumni of this esteemed department. For over thirty years, I have enjoyed and benefitted from excellent colleagues. The chance to pay that back in a small way was an opportunity I could not decline.

I know you will all help me continue the tradition of excellence that has marked this amazing department for over a century.

With high hopes for our bright future together,

Wen-mei Hwu
AMD Jerry Sanders Chair of Electrical and Computer Engineering
ECE ILLINOIS Acting Department Head

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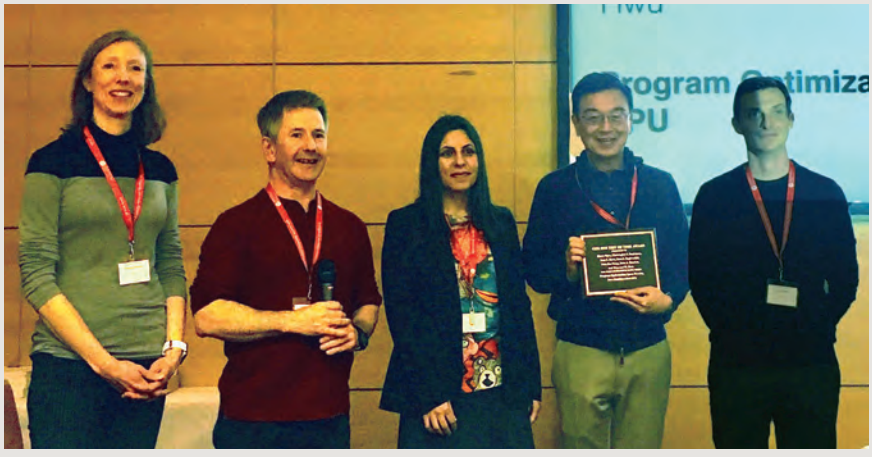
Catherine Somers
ECE ILLINOIS Assistant Head



From left to right: ECE ILLINOIS alumna Teresa Johnson (BSEE '93, MSEE '95, PhD '98), Google, Program Co-Chair of CGO 2018; Michael O'Boyle, University of Edinburgh, Program Co-Chair of CGO 2018; Sara Baghsorkhi (PhD '11), Intel; Prof. Hwu; Aaron Smith, Microsoft, Sponsor Chair of CGO 2018.

HWU WINS CGO TEST OF TIME AWARD

ECE ILLINOIS Professor **Wen-mei Hwu**, new acting department head and AMD Jerry Sanders Chair of Electrical and Computer Engineering, recently won the CGO Test of Time Award, also known as the Most Influential Paper Award presented by the International Symposium on Code Generation and Optimization. His paper is entitled "Program Optimization Space Pruning for a Multithreaded GPU."

Originally published in the CGO proceedings in April 2008, the paper was co-authored by several students, now alumni, including **Shane Ryoo** (BSEE '00, MSEE '04, PhD '08), **Christopher Rodrigues** (MS '08, PhD '14), **Samuel S. Stone** (MS '07), **Sara Baghsorkhi** (PhD '11), **Sain-Zee Ueng** (MSEE '04), and **John A. Stratton** (BSCompE '06, MS '09, PhD '13). The researchers revealed the complexity involved in optimizing applications for highly parallel systems and introduced one relatively simple methodology for reducing the workload involved in the optimization process by as much as 98 percent. Their work was based on the GeForce 8800 GTX using CUDA, one such highly parallel system, and they proposed an approach for attacking the complexity of optimizing code by developing metrics to judge the performance of an optimization configuration.

With the rise of inexpensive, single-chip, massively parallel platforms, more developers will be creating highly parallel applications for platforms that will need to be optimized, emphasizing why Hwu's research is so valuable.

OELZE NAMED ASSOCIATE HEAD FOR GRADUATE AFFAIRS

In June, ECE ILLINOIS Professor **Michael Oelze** was appointed associate head for graduate affairs at ECE ILLINOIS. He joined the faculty in 2005, earlier completing a post-doc in the Bioacoustics Research Lab at ECE ILLINOIS. His research focuses primarily in the fields of biomedical imaging, bioengineering, and acoustics. He has also worked with ultrasound/tissue interaction, including cancer detection using quantitative ultrasound, ultrasound microscopy, bioeffects of ultrasound, ultrasound-based therapies, and coded excitation.

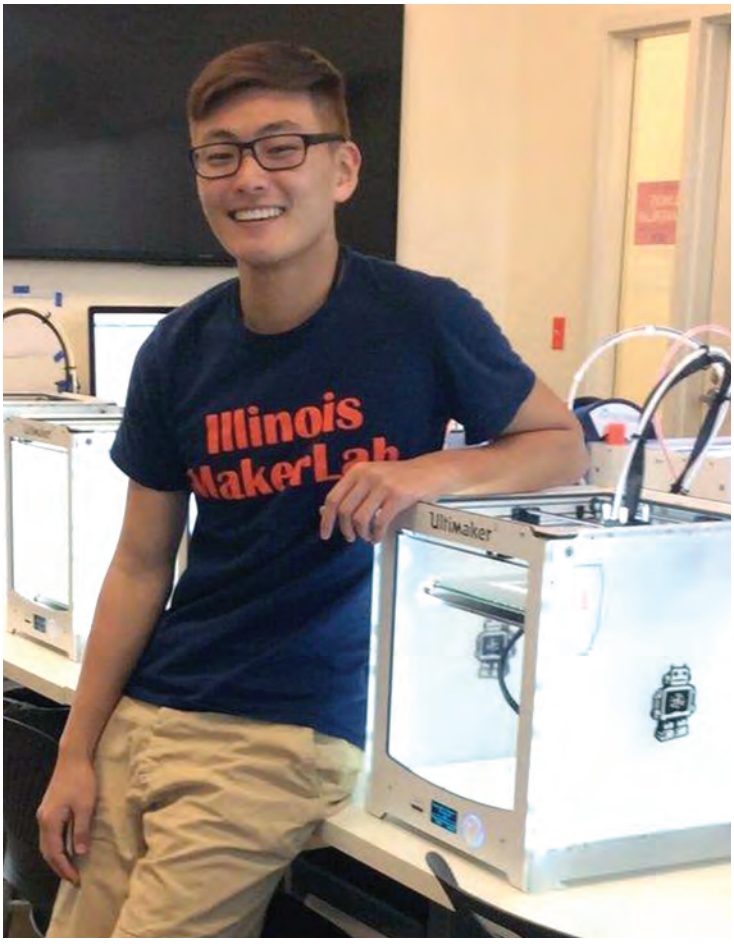
Over the past decade, Oelze has served on several departmental graduate committees and faculty search committees and has been honored many times on the "List of Teachers Ranked as Excellent by Their Students." His experience will assist the department in maintaining excellence and success within the graduate programs.

ECE ILLINOIS WELCOMES NEW ASSISTANT HEAD

Catherine Somers has been named assistant head of ECE ILLINOIS. A 20-year employee of the University of Illinois, Somers spent seven years in the Department of Civil and Environmental Engineering before beginning her position in ECE ILLINOIS this summer.

A native of Champaign, Somers knew the university was home to exceptional engineering. She remembers watching the north part of campus develop as new buildings sprouted up, each a "physical representation of that excellence." Now at ECE ILLINOIS, she embraces the challenge of providing preeminence at scale.

"Anyone can be born with talent or intelligence," Somers says. "Our mission is to provide access [to a world-class education] to the sons and daughters of Illinois as well as to families from across the country and around the globe. Our students are prepared to improve the world, help others, and make a positive difference. We hope they leave here with knowledge, wisdom, and compassion."



UNDERGRAD LEADS TEAM OF MAKERS COMPETING ON PBS

ECE ILLINOIS CompE undergraduate **Dashiell Kaemon Kosaka** is part of a four-person Illinois team that has been selected for season 3 of "Make48," a nationally televised show where students compete to develop an idea, create a prototype, and present their product to a panel of judges in 48 hours.

Eleven university teams will be competing, and three winners will be chosen based on product originality, problem solution, marketability, and other factors. The rest of the season will focus on the process of bringing the products of those three teams to market.

The show films at Stanley Black & Decker Innovation Lab in Towson, Maryland. "Make48" is presented and distributed to public television stations nationwide. The first two seasons are airing on PBS.

Senior Dash Kosaka in the Illinois MakerLab
Photo credit: Illinois MakerLab

AL-HASSANIEH RECEIVES NSF CAREER AWARD

As demand for mobile and wireless data continues to increase, the strain it has caused led the Federal Communications Commission to open up bandwidth in high-frequency spectrums. These millimeter wave (mmWave) bands are expected to play an important role in next-generation cellular networks and future 802.11 wireless LANs.

ECE ILLINOIS Associate Professor **Haitham Al-Hassanieh** was recently awarded a five-year, $550,000 NSF CAREER Award to address the challenges these mmWave bands bring, in order to take full advantage of these high-frequency spectrums.

"Experts are predicting that demands on technology companies are rising so fast, the current wireless networks can't keep up with it," Hassanieh says. "I believe high frequencies can help with this problem, but the question is if we're going to be able to make it practical and leverage it properly and to its full extent. I believe this research will allow us to increase data rates and provide internet connectivity to many more people."

EDEN'S TEAM DEMONSTRATES FIRST LASER TO GENERATE LASER BEAMS WITH FRACTAL PATTERN

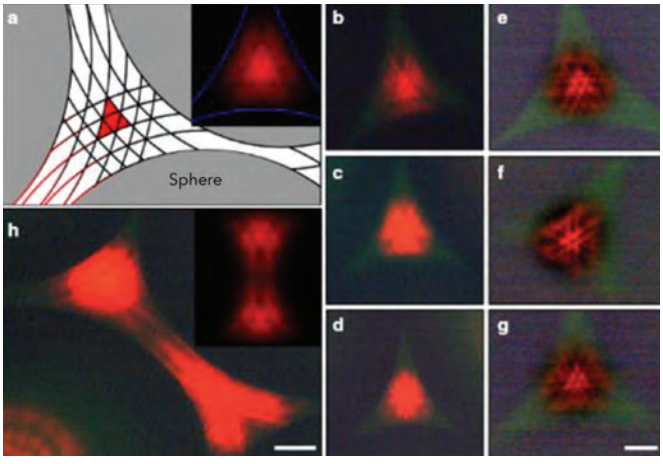


Fig. 3 from the team's paper, including observed and calculated fractal laser modes for three and four microsphere topologies.

Intel Alumni Endowed Chair in Electrical and Computer Engineering **J. Gary Eden**'s research team has demonstrated the first laser to generate laser beams having a fractal pattern. The team includes ECE ILLINOIS graduate student Austin William Steinforth, alumnus Thomas Casey Galvin (BSEE '08, MSEE '11, PhD '15), and bioengineering graduate student Jose A. Rivera. The research group's paper, "Fractal Modes and Multi-beam Generation from Hybrid Microlaser Resonators," was published in July by *Nature Communications*.

Conventional lasers produce Gaussian beams having cross-sectional shapes determined primarily by the separation between the two laser mirrors and their radii of curvature. In contrast, laser fractal modes were discovered by placing arrays of microspheres in the laser resonator, which led to fractal laser modes being produced in the gaps (interstices) between the spheres. If the spheres were "close-packed," forming a hexagonal pattern, the fractal laser modes consisted of triangles of differing sizes. When a gap was carefully opened in the microsphere, the resulting fractal patterns comprised the superposition of rectangles or squares.

Eden commented on the relevance and impact of this discovery. "One significant aspect of this work is that laser beam cross-sectional patterns are no longer confined to the specific parameters of the laser resonator but can now be designed to match a mathematical expression. This, in turn, suggests that fractal laser modes will be of continuing interest in their own right, but also for optical information processing and imaging."

ECE ILLINOIS students Sankruth Kota, Gautam Putcha, Jacqueline Jiang, Santan Katragadda, Monil Pathak, and Murugan R. Narayanan, all computer engineering majors, were among this summer's class of John Deere interns.

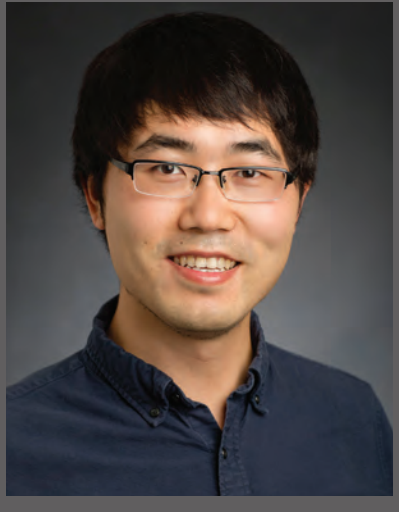
JOHN DEERE INTERNS GAIN SKILLS AND EXPERIENCE

This summer, Corporate Connections partner John Deere invited university representatives to hear from ECE ILLINOIS and CS students about their experiences as John Deere information technology interns.

Each intern gave a short presentation focusing on the value of the internship opportunity. Many stressed the technical skills they developed and how they were able to experience the culture of John Deere while working on projects with existing teams. For some students, the experience was their first working in a corporate environment. Many mentioned the benefits of attending company networking events and participating in company-wide volunteer projects, including Habitat for Humanity.

"John Deere is an excellent corporate partner to ECE ILLINOIS and CS," says Nikki Slack, assistant director of corporate relations, who co-manages the Corporate Connections program. "Internships are important experiences for students. These presentations were a great way to hear what they learned first-hand."

$1.75M GRANT BOOSTS IOPTICS LAB'S ULTRAFAST BIOIMAGING RESEARCH



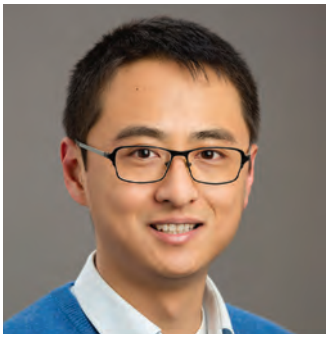
ECE ILLINOIS Assistant Professor **Liang Gao**'s research is improving microscopic imaging, and a new $1.7 million grant from the U.S. Department of Health and Human Services will give his team a boost as they pursue ultrafast bioimaging and the promise of several fundamental scientific discoveries.

To gain a deeper understanding of the underlying biological mechanisms at the molecular level, scientists need ultrafast imaging tools. These molecular interactions and events can take tens of microseconds or tens of femtoseconds. (A femtosecond is one quadrillionth of a second.) Current technology can't robustly capture these events.

Gao's group proposes a solution to compress image data before it is digitized and transferred to the host computer, thereby reducing the bandwidth and hardware needed to capture even high-speed image data. This research will explore frame rates up to ten THz that conventional high-speed cameras can't capture. "The resultant research program will ultimately lead to a new generation of ultrafast bioimagers and make transformative advancements to the state-of-the-art methods," Gao says.

FACULTY RECEIVE NSF GRANT TO DEVELOP NEW SPECTRUM SENSORS





Left to right: Haitham Al-Hassanieh, Songbin Gong, Jin Zhou

ECE ILLINOIS faculty members **Haitham Al-Hassanieh**, **Songbin Gong**, and **Jin Zhou** have received an NSF grant to develop a new generation of energy-efficient chip-scale spectrum sensors that could lead to a more efficient use of our radio frequency (RF) spectrum.

The team proposes to develop such energy-efficient and low-cost spectrum sensing systems by fusing recent innovations in RF acoustic-resonator-based devices, reconfigurable circuits, and sparse signal processing.

Zhou, the principal investigator on the project, says, "The most exciting part of this project is its multidisciplinary nature, which spans different layers of abstraction, from device to circuit and to algorithm. I believe this cross-layer approach is what makes our solution stand out."

ALUMNA HELPED DEVELOP SUMMIT, IBM'S NEW SUPERCOMPUTER

Summit is a supercomputer capable of running an estimated 200,000 trillion calculations per second. ECE ILLINOIS alumna **Hillery Hunter** (BSEE '99, MS '02, PhD '04), IBM Fellow, CTO, and Vice President of Cloud Technology, helped develop Summit's memory and computing speed.

With the concurrent rise of artificial intelligence, Summit's power is ideal for applications implementing artificial intelligence since it is capable of processing massive amounts of data rapidly.

"When you create AI faster, it's not just that you get an answer or a model for AI more quickly," Hunter said in an interview with CNBC. "It's that it really unleashes the creativity of the AI scientists because they can explore more options."

At Illinois, Hunter was advised by AMD Jerry Sanders Chair of Electrical and Computer Engineering Wen-mei Hwu.

ALUMNA NAMED FIRST CHIEF TALENT OFFICER OF THOUGHTWORKS

ECE ILLINOIS alumna **Joanna Parke** (BSEE '00) has been named to the inaugural position of chief talent officer of Chicago-based ThoughtWorks, a global software and digital transformation consultancy.

Parke first joined ThoughtWorks in 2003 as a software developer. Most recently, she was managing director for North America. In 2015, she was named to *Crain's Chicago Business* "40 under 40" for her contributions toward talent development, notably doubling the percentage of technical women at ThoughtWorks. In 2017, Parke received the ECE ILLINOIS Young Alumni Achievement Award "for creating radical change in the hiring practices of the tech sector through dedication, innovation, and leadership."

FACULTY COLLABORATES ON $8.3 MILLION DARPA INITIATIVE

The University of Illinois has received an $8.3 million grant to develop foundational computing technologies for next-generation autonomous systems for defense and commercial applications. The multi-university initiative includes collaborators from Princeton University, Raytheon Missile Systems (RMS), and GLOBALFOUNDRIES. It is being funded by DARPA's Foundations Required for Novel Compute (FRANC) research program.

The FRANC team at Illinois includes **Naresh Shanbhag**, Jack S. Kilby Professor of Electrical and Computer Engineering, and ECE ILLINOIS Professor **Pavan Kumar Hanumolu**. The team will develop novel computing technologies that address the needs of autonomous sensory platforms that make mission-critical decisions in real-time, within strict thermal limits and while withstanding high-radiation space environments.

FRANC is one of the six programs under DARPA's recently established Electronic Resurgence Initiative (ERI), whose goal is to "more constructively enmesh the technology needs and capabilities of the defense enterprise with the commercial and manufacturing realities of the electronics industry." Of the six projects funded through FRANC, the Illinois project is the largest, according to *IEEE Spectrum*.

DEPARTMENT HEAD NEWS

In August, **Wen-mei Hwu**, AMD Jerry Sanders Chair of Electrical and Computer Engineering, was named ECE ILLINOIS acting department head, succeeding **William H. Sanders**, Donald Biggar Willett Professor of Engineering. Sanders was appointed interim director of the Discovery Partners Institute (DPI), a new world-class innovation center led by the University of Illinois System (*for more on DPI, see p. 34*).

As DPI's interim director, Sanders leads all facets of planning and operations, including planning to build the new downtown Chicago institute, faculty and staff hiring and engagement, development of research and educational programs, and forging agreements with corporate and academic partners. DPI will operate as an executive office of the president within the University of Illinois System. As such, Sanders will work as a member of the leadership team in system offices and work closely with the chancellors, provosts, and deans of all three system universities.

Sanders said he is committed to fulfilling DPI's promise of becoming a new model for higher education that combines the strengths of industry, academia, and government in a way that drives both academic discovery and economic growth.

"DPI will harness the unique strengths and scale of the U of I System universities – together with academic and industry partners from Chicago, the state, and the world – to create an unstoppable engine for innovation," he said.

Hwu assumes the acting department head responsibilities while also leading the IBM-Illinois Center for Cognitive Computing Systems Research and serving as a PI on the Blue Waters supercomputing project. He is also a fellow of the Institute of Electrical and Electronics Engineers (IEEE) and the Association for Computing Machinery (ACM).

RETIREMENTS

PATRICIA FRANKE

Patricia Franke retired in 2017 after 15 years as a member of the ECE ILLINOIS faculty. She received her bachelor's degree in electrical engineering from the University of Maryland in 1980 and her PhD from ECE ILLINOIS in 1996. Franke joined the University of Illinois in 2002 and served as a lecturer until her retirement.

Her research interests include computational fluid dynamics, computational electromagnetics using finite-difference time-domain techniques, radar and optical remote sensing of the upper atmosphere, and atmospheric dynamics through analysis of radar data, lidar data, and numerical simulations of different flow types.

SETH HUTCHINSON

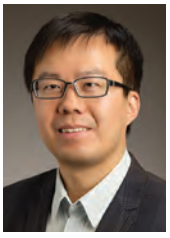
Seth Hutchinson joined the ECE ILLINOIS faculty in 1990. He received all three of his degrees in electrical engineering from Purdue University. During his time at Illinois, Hutchinson served as associate head for undergraduate affairs and developed courses including ECE 550: Advanced Robotic Planning, ECE 470: Introduction to Robotics, and ECE 379: Robot Sensing.

In 2018, Hutchinson was named professor emeritus of electrical and computer engineering at the University of Illinois. He now serves as professor and KUKA Chair for Robotics in the School of Interactive Computing and the associate director of the Institute for Robotics and Intelligent Machines at the Georgia Institute of Technology.

NEW FACULTY











Eleven new faculty members have joined the department this calendar year. Their interests range from quantum photonics to e-crime and system security, and all are experts in their respective fields. Pictures are shown in alphabetical order.

XU CHEN

Teaching Assistant Professor Xu Chen (BSEE '05, MSECE '14, PhD '18) continues his career at ECE ILLINOIS after earning all three of his degrees from the department. He also gained industry experience at Apple and IBM. His research interest is computational electromagnetics.

YUTING CHEN

Teaching Assistant Professor Yuting Chen (BSEE '07) has been an ECE ILLINOIS lecturer since 2015. After earning her PhD in 2011 from Rensselaer Polytechnic Institute, she was a staff software engineer at IBM. Chen pursues excellence in teaching and mentoring through service across ECE ILLINOIS and the College.

ZUOFU CHENG

Teaching Assistant Professor Zuofu Cheng (BSEE '06, MSEE '10, PhD '14) has been part of the ECE ILLINOIS faculty since 2014. He has a research background in applications of heterogeneous computing in video games and virtual reality.

ERIC CHITAMBAR

Associate Professor Eric Chitambar joins ECE ILLINOIS from Southern Illinois University. A rising star in quantum information, Chitambar is best known for his insights into entanglement theory. His work earned him the prestigious NSF CAREER award in 2014.

KEJIE FANG

Assistant Professor Kejie Fang joined ECE ILLINOIS in spring 2018, after working as a postdoctoral scholar and senior research scientist at Caltech. He is interested in nanophotonics and quantum photonics, with an emphasis on physics exploration and chip-scale integration.

WEI HE

Teaching Assistant Professor Wei He joined ECE ILLINOIS as a lecturer in 2014 after working as a faculty member at the Institute of Microelectronics of the Chinese Academy of Sciences in Beijing and as an instructor of physics and math at the CCB School of Westchester in Hartsdale, New York. His academic interests are in semiconductor devices and materials.

BIN HU

Assistant Professor Bin Hu joins ECE ILLINOIS from the Wisconsin Institute for Discovery at the University of Wisconsin-Madison. His research focuses on building fundamental connections between control and machine learning.

JIAN HUANG

Assistant Professor Jian Huang joined the Illinois faculty in spring 2018. His research interests lie in the areas of computer systems, including operating systems, systems architecture, systems security, distributed systems, and the intersections of those areas.

DIMITRIOS KATSELIS

Teaching Assistant Professor Dimitrios Katselis joined the Coordinated Science Lab in 2014 as a research associate and joined ECE ILLINOIS as a lecturer in 2015. His research interests are at the intersection of applied probability, machine learning, stochastic systems and control, information theory, system identification, and signal processing.

KIRILL LEVCHENKO

Associate Professor Kirill Levchenko (LAS '01, MATH and CS) comes to ECE ILLINOIS from the University of California, San Diego. His current research applies evidence-based techniques to study e-crime and cyber-physical system security.

ILAN SHOMORONY

Assistant Professor Ilan Shomorony joins ECE ILLINOIS from the University of California, Berkeley. He has also worked as a data scientist at Human Longevity, Inc. His research focuses on fundamental limits of wireless multihop networks.

SEARCHING FOR THE NEXT SMALL (AND BIG) THING

For such a tiny part, the transistor plays a huge role in our lives. Transistors—invented in 1947 by former ECE ILLINOIS Professor John Bardeen and two other physicists—have helped usher in the information revolution. They are ubiquitous in technology. Their low cost, flexibility, and reliability have allowed for amazing advancements in computers, machines, equipment, products—anything that involves microelectronics.

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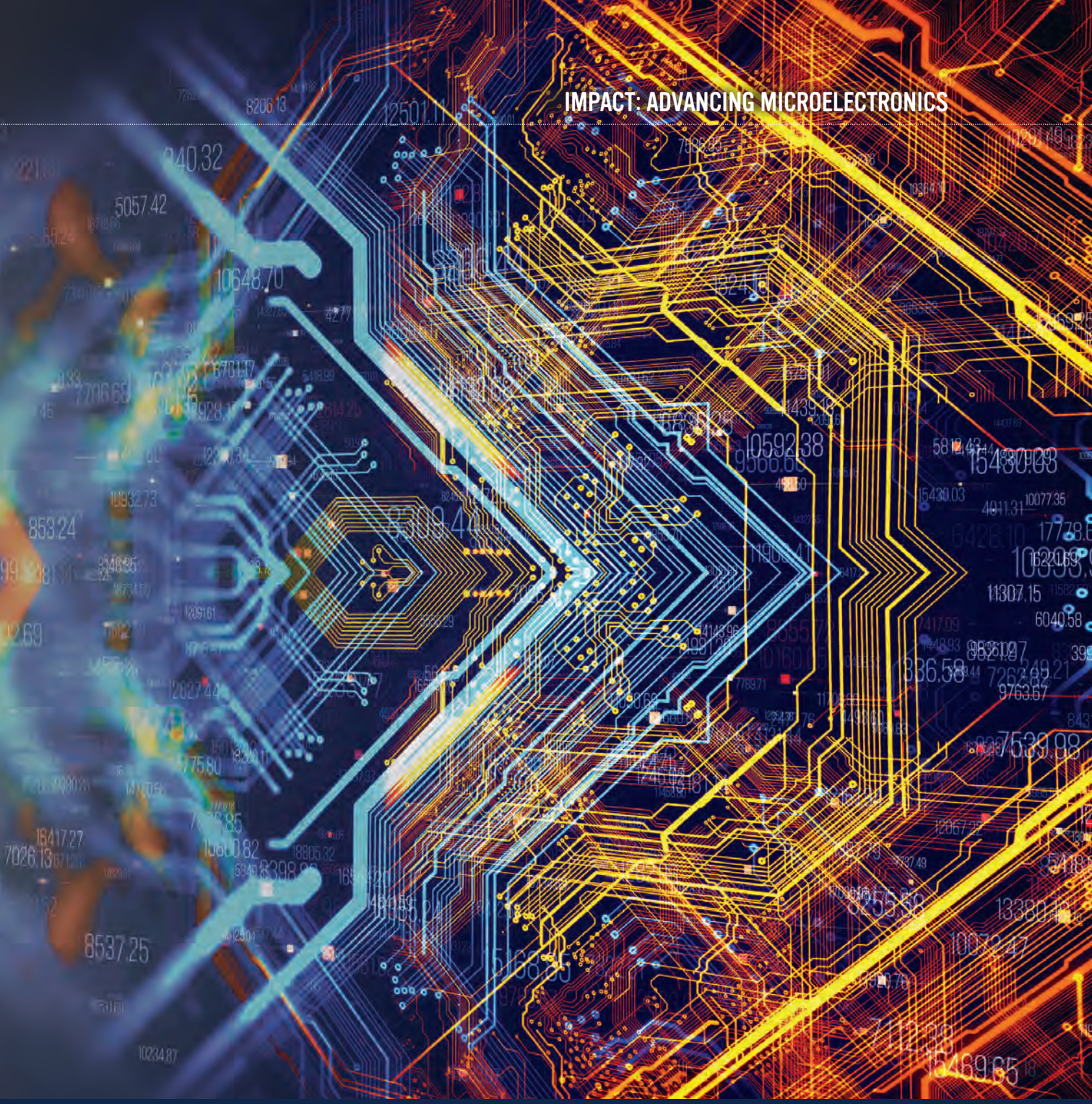

“YOU CAN SHRINK TRANSISTORS ONLY SO FAR. THEN YOU NEED TO LOOK FOR ADVANCEMENTS IN OTHER WAYS.”

WEN-MEI HWU

"EVERYTHING THAT WE DO TODAY WILL GET CONNECTED BY THIS TECHNOLOGY. SO WHAT DO I EXPECT TO SEE AT THE END OF THIS RESEARCH? I EXPECT A BETTER WORLD."

SARITA ADVE

And those advancements have been incremental throughout the years. Consider this: Intel's 22nm 3D transistors, introduced in 2011, run over 4,000 times as fast as Intel's first microprocessor, introduced in 1971. They use about 5,000 times less energy, and their price per transistor dropped by a factor of about 50,000. The company manufactures more than 5 billion transistors every second.

That adds up to incredible speed at very affordable costs, which translates to ever-improving technology. There is only one catch, but it is a big one. It is embodied in Moore's law, which projects that the number of transistors in a dense integrated circuit doubles every two years.

THE PROBLEM

"The overarching problem is the semiconducting industry has been on a scaling path for almost 50 years," says ECE ILLINOIS Professor **Wen-mei Hwu**, who is also affiliated with the Coordinated Science Lab. But he believes the pace of advancement based on this scaling process is coming to an end soon, "because as the transistors get smaller and smaller, the process has become way too expensive," Hwu adds. "In other words, you can shrink transistors only so far. Then you need to look for advancements in other ways."

This is the focus of a $3.75 million grant awarded to the University of Illinois to be part of a team conducting research to increase the performance, efficiency, and capabilities of electronics systems for both military and commercial applications.

John Bardeen started a revolution in the microelectronics industry. And Hwu, ECE ILLINOIS Associate Professor **Nam Sung Kim**, and Professor **Sarita Adve** of the Department of Computer Science and ECE ILLINOIS affiliate, are tasked with helping to take that revolution to a higher level.

BRINGING THE PIECES TOGETHER

First announced earlier this year, the team's work is funded by the Defense Advanced Research Projects Agency (DARPA) and U.S. industry participants. Overall funding for the program, called JUMP (the Joint University Microelectronics Program), exceeds $150 million and has resulted in a collaborative network of six research centers spread across the country. The Illinois contingency—headed by Hwu, Kim, and Adve—comprises part of one of two "horizontal" centers for the project. Those two centers will intersect with four "vertical" centers.

"We are an Applications Driving Architectures Center," says Kim, another Coordinated Science Lab researcher. "A key role of our center is to synergistically put all the activities of other vertical centers together so we can cost-effectively produce efficient integrated systems for future computing applications. We are bringing all these pieces together to get the maximum benefit out of the individual centers' efforts."

The Applications Driving Architectures (ADA) Center is developing circuits and architectures to implement computation, communication, and storage applications and support the needs of the four vertical centers, which are studying RF to terahertz sensors and communication systems, distributed computing and networking, cognitive computing, and intelligent memory and storage.

The ADA Center formally began in January and is on a three-year renewable contract.

"I am a strong believer of long-term research," Adve says. "All of my projects last many years. I tell my students it's a story that you're unfolding. When I think about my work over the last 20 years, I think of it as a sequence of chapters in a story where each chapter makes an impact that builds on the previous one." To that end, JUMP is eyeing an 8- to 12-year research time frame that will lead to defense and commercial opportunities from 2025 to 2030.

ARCHITECTURAL IMPROVEMENTS

Hwu, whose career (as an undergraduate student, grad student, and professor) spans 40 years, has seen gradual changes in computer architecture over that time.

"It has been an extremely slow evolution," he says, "but now we're seeing a very dramatic change. When the industry is going through slow evolution, you can take the current generation of hardware and change some of the software and do some experiments and then predict some of the benefits for making some small changes in the next generation. But when

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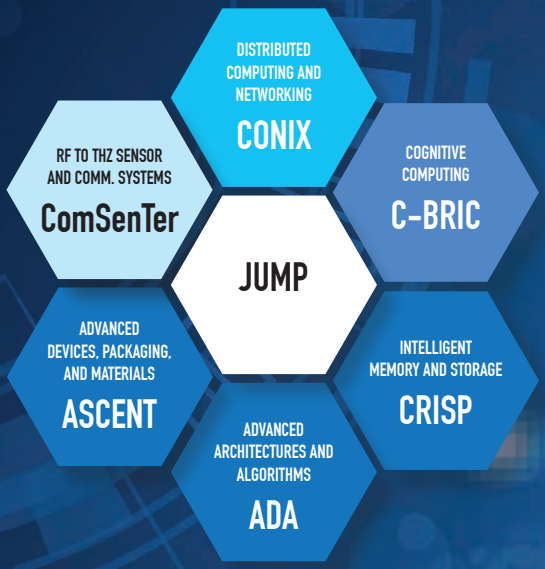
JUMP Start



The structure of the Joint University Microelectronics Program (JUMP) includes six centers: four "vertical" centers, which focus on application-oriented goals, and two "horizontal" centers, which drive foundational developments in a specific discipline to create disruptive breakthroughs.

Illinois is one of several universities associated with the Applications Driving Architectures (ADA) Center, one of the two horizontal centers. The others include Stanford, MIT, UC Berkeley, Michigan, Washington, Princeton, and Harvard. The ADA is working to create a modular approach to system hardware and software design.

The other horizontal center is the Applications and Systems driven Center for Energy-Efficient Integrated Nanotechnologies (ASCENT), which is tackling the data-transfer bottlenecks and energy-efficiency challenges associated with current electronic devices.

The four vertical centers include:

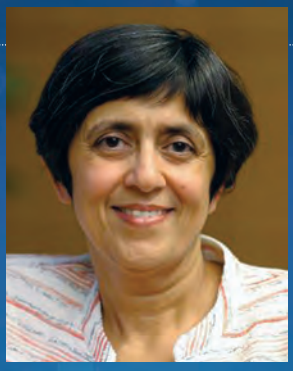
The Center for Brain-inspired Computing Enabling Autonomous Intelligence (C-BRIC), which is working to advance cognitive computing to enable a new generation of autonomous intelligent systems.

The Center for Converged TeraHertz Communications and Sensing (ComSenTer), which is focusing on developing technologies for a future cellular infrastructure to support the autonomous vehicle revolution and the emergence of intelligent highways.

The Computing On Network Infrastructure for Pervasive Perception, Cognition, and Action (CONIX), which is developing an architecture for networked computing that lies between edge devices and the cloud.

The Center for Research on Intelligent Storage and Processing-in-memory (CRISP), which is working to topple the "memory wall"—a 70-year-old technical bottleneck in computer systems that is hindering the use of big data for technical discovery.


Nam Sung Kim


Sarita Adve


Wen-mei Hwu

things start to be so different, you start to lose that kind of trajectory."

In previous generations, improvements were easier, Hwu says. "You had a lot more transistors to play with and their power efficiency was getting better, so, from an architect's point of view, we didn't have to make dramatic changes. Now, we need to think about how we organize the devices that we have to get better transistor energy efficiency."

Adve agrees. "A huge part of computer performance improvement is going to come from how computer architects can organize these devices and expose them to the program," she says. "In the past, computer architects were wildly successful in that they defined a general interface, the basic instructions that computers execute."

That, she says, "enabled a lot of innovation in the hardware, because we knew these were the instructions we had to design to, and the hardware designers were free to innovate as long as the hardware would execute these instructions."

TAKING A LEAP FORWARD

One of the key target applications is artificial intelligence (AI) apps, which is used extensively in society today: in medicine, finance, healthcare, education, transportation, heavy industry, the military, aviation, telecommunications, and many more industries.

"All the innovations in these industries rely on computer technology," Kim says. "We are enabling these innovations for our everyday lives."

Hwu jokingly compares their work to that of plumbers. "We are providing the foundation, the infrastructure, for people to build safer vehicles, to build better education for students, to be able to understand financial risks better," he says. "We won't take a lot of the top-level application glories, but we will make sure that they can still have the glories."

Both Hwu and Adve were involved in what Hwu calls the "previous generation of the ADA Center, C-FAR" (Center for Future Architectures Research). "A good chunk of the software synthesis that we're doing here was also supported by C-FAR," Hwu says.

"The C-FAR work laid the foundation for this work and increases our confidence that we can meet the challenges," adds Adve. "In C-FAR, we were working on understanding what the issues were. Now, we are taking that work to the next level."

GAME-CHANGING RESEARCH

The project involves a number of graduate students as well.

"The students get great exposure," Adve says. "They go to these [center] meetings and interact with some of the best people in the industry and work collaboratively with them. It's a great experience for students."

Hwu and Kim's students are building prototype software, hardware, and libraries. "It's hard work," Hwu says. "The amount of time it takes them to complete their theses is even more uncertain. So how we support our students as they take on these high-risk systems construction work that can have a lot of land mines, that keeps us thinking."

Getting to that next level offers a lot of hope for the future of the microelectronics industry—though that future is murky at the moment, Hwu says. "It's hard to say where we are going to be in five years," he notes. "That's part of the research. A lot of the future is defined in the process."

"I think this research can be a game-changer," Adve says. "This industry is at a point right now where the path is really not clear. This is a huge opportunity for us. It might even be a once-in-a-lifetime chance to influence in a big way where the industry goes. Everything that we do today will get connected by this technology. So what do I expect to see at the end of this research? I expect a better world."

Tom Hanlon

Taking on the Challenge

"IT'S HARD TO SAY WHERE WE ARE GOING TO BE IN FIVE YEARS. THAT'S PART OF THE RESEARCH. A LOT OF THE FUTURE IS DEFINED IN THE PROCESS."
WEN-MEI HWU

The Illinois team of Wen-mei Hwu, Sarita Adve, and Nam Sung Kim, as well as the ADA Center, face many challenges in this work, including:

Balancing the need to build customized systems with the need to generalize those systems for greatest possible use among applications. "There are so many applications out there; we cannot design something for every application," Adve says. Kim agrees. "Customizing hardware for different applications becomes very expensive," he says. "So one of the objectives of our center is to provide building blocks to make a specialized process that operates in a more efficient manner."

Specifying software at a higher level. "The software should be synthesized so instead of people writing every line of code for each level of software, the software should be specified at the higher level—more at the algorithm level," Hwu says.

Increasing efficiency. "We need to think about how we can compress things into fewer operations, do less work to get higher efficiency," Hwu says. "One of the things Nam Sung and I have been working on is lowering the system overhead by making the entire data always be in the main memory." Data movement, Adve agrees, is highly inefficient. "Let's say I have a self-driving car," she says. "It has many different components. I might want to specialize the computation of each of these components, but they have to communicate data with each other. How do I connect these specialized components together so that they form a whole system with minimal overheads in communication? You need efficient interfaces."

Improving the interface between hardware and software. "The interface for communicating data between different components of a system is becoming a real source of inefficiency," Adve says. "In the past, when we had general-purpose systems, everything ran on pretty much the same interface. But when you design something to be so general purpose, to be everything for everybody, it cannot be efficient for everything. We are designing the data communication interfaces and protocols for the next generation of specialized systems."

Working without prototypes. "The applications are changing, so system design follows a moving target," Adve says. "It's very hard to do this kind of research without building prototypes, but building prototypes is hard, especially in hardware."

Redeveloping libraries. "Software rely on libraries," Hwu says. "These libraries need to be redeveloped and retuned for each type of hardware. Right now there's a vacuum in the industry in terms of how library functions in the future will be able to keep up with the hardware."

FOCAL POINT

» THIS FALL, ENGINEERING AT ILLINOIS WELCOMED THE LARGEST INCOMING UNDERGRADUATE CLASS TO DATE: 1,559 ENGINEERS. AMONG THOSE, ECE ILLINOIS WELCOMED 370 STUDENTS (IN PURPLE T-SHIRTS), INCLUDING 344 FRESHMEN AND 26 TRANSFER STUDENTS.

PHOTO BY THOMPSON-MCCLELLAN PHOTOGRAPHY

POWER-PACKED CONFERENCE

The IEEE Power and Energy Conference at Illinois (PECI) is the perfect place for students to investigate future power and energy technologies. It also provides a unique opportunity for members of the joint IEEE Power and Energy/Power Electronics/Industry Applications (PES/PELS/IAS) Chapter at Illinois, who host the event, to gain valuable leadership and organizational skills.

Founded in 2010, the IEEE PECI is the oldest annual, student-run international conference focused on power and energy technology. By providing a forum for students in the early phases of their careers to present their research progress to a technical audience of peers, professors, and industry researchers, PECI aims to inspire students to pursue a career in the power and energy field.

The 2018 PECI, held on the Illinois campus in February, included 170 attendees from the United States and abroad, with participants from 44 different universities as well as industry.

"Organizing this international conference enables graduate students in the Power and Energy Group at ECE ILLINOIS to learn the importance of professional service first-hand," says **Enver Candan**, graduate student and co-chair of the 2017 IEEE PECI. "Our student-led committee also proposes new ways to enrich the networking and professional development opportunities at PECI each year."

Although several registration scholarships have been given annually for authors, this year an NSF grant written by chapter members provided support for 33 non-authors to participate in the conference experience, including four students from Navajo Technical University in New Mexico, by covering their registration and accommodation expenses.

"Conference volunteers gain this valuable experience writing grants, reviewing digests, and handling travel logistics with help from **Joyce Mast**, a member of ECE's research support staff, Dr. **Peter Sauer**, the Grainger Chair in Electrical Engineering, and other fantastic mentors, who go above and beyond to help PECI succeed," says **Mariola Ndrio**, graduate student and co-chair of the 2018 IEEE PECI.

"All of the hard work required to organize PECI ultimately pays off both technically and socially when conference attendees share feedback about their positive experiences at the conference. Volunteering with PECI during my graduate studies has truly been a fulfilling and rewarding experience."

ECE STUDENTS GET PLUGGED IN

The PECI provided an opportunity for attendees to extend the conversation about vital topics.

"The control, storage, and appropriate utilization of energy is at the core of every system," says graduate student and fellow **Christopher Brandon Barth**, co-chair of the 2018 PECI. "While increasing the penetration of renewable energy resources will reduce our nation's dependence on foreign energy, what will be the impact of connecting these distributed generators to the aging electrical grid? There was a meaningful dialogue about this question throughout the conference."

The 2018 PECI focused on "Renewable Integration for a Sustainable Future" and included:

- Four keynote presentations: one on humanitarian service by **Henry Louie**, associate professor of electrical and computer engineering at Seattle University; one on career development by **Mariesa Crow**, professor of electrical engineering at Missouri S&T; one on the challenges of renewable energy integration by Dr. **Stanley Atcitty**, an energy storage systems researcher at Sandia National Laboratory; and one on control by ECE alumnus **Brian Johnson**, assistant professor of clean energy and electrical engineering at the University of Washington (MSEE '10, PhD '13)

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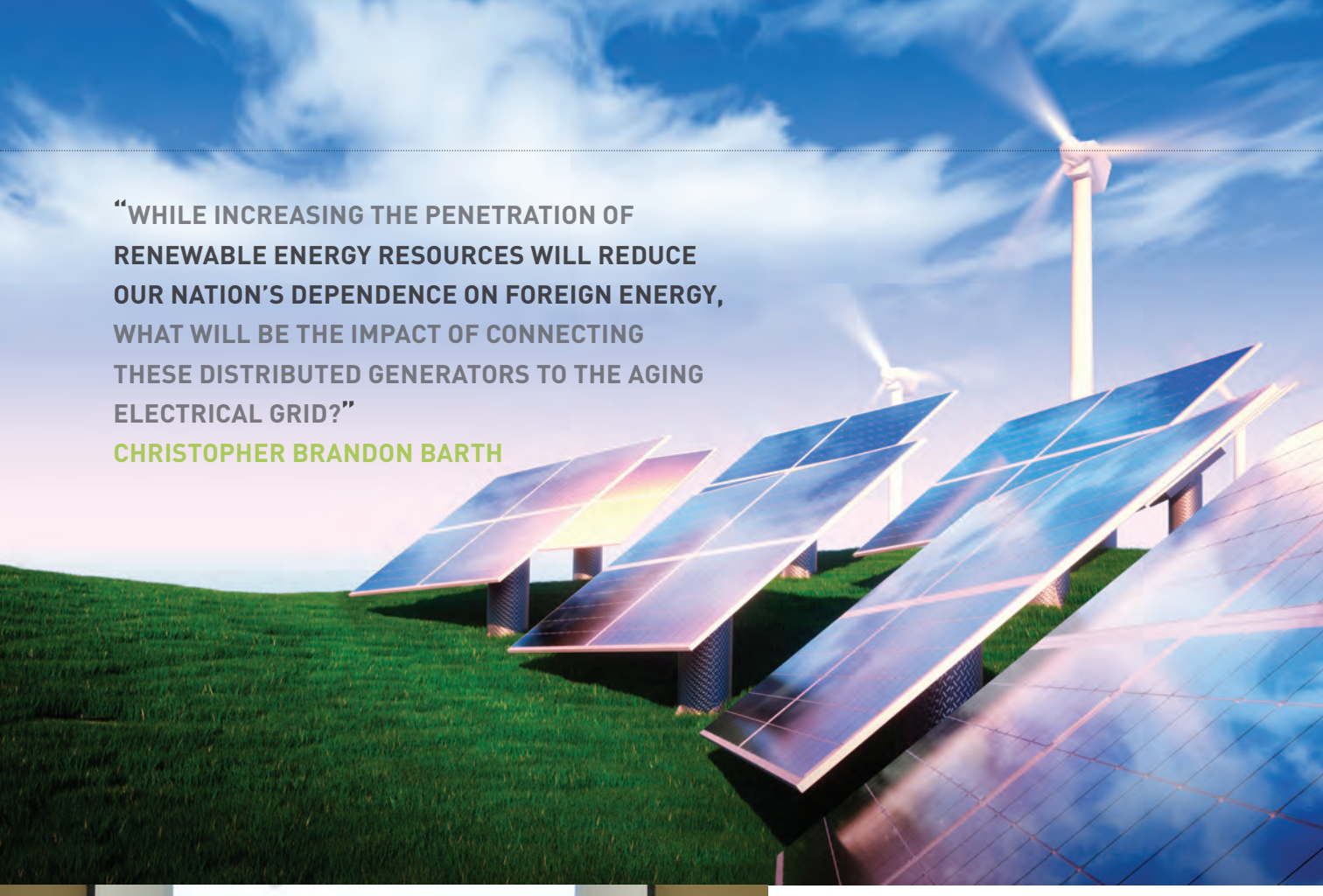


"WHILE INCREASING THE PENETRATION OF **RENEWABLE ENERGY RESOURCES WILL REDUCE OUR NATION'S DEPENDENCE ON FOREIGN ENERGY,** WHAT WILL BE THE IMPACT OF CONNECTING THESE DISTRIBUTED GENERATORS TO THE AGING ELECTRICAL GRID?"

CHRISTOPHER BRANDON BARTH

The IEEE PECI is organized and run entirely by graduate students from the Illinois joint IEEE PES/PELS/IAS chapter. Front row, left to right: Derek Chou, Samantha Coday, Mariola Ndrio, Christopher Barth, Cecilia Klauber, Joyce Mast (ECE Research Support Staff), and Andy Yoon. Back row, left to right: Thomas Foulkes, Nathaniel Renner, Jason Galtieri, Samuel Utomi, Adriano Lima Abrantes, Zitao Liao, Enver Candan, Austin Jin, Nathan Brooks, Dipanjan Das, and Avinash Madavan; not pictured: Xuan Yi, Andrew Stillwell, Pei Ng, Joseph Liu, and Jackson Lenz.

This year's conference included a tour of Ameren's state-of-the-art microgrid facility on the southwest edge of campus.

"PECI IS BLESSED EVERY YEAR TO HAVE NUMEROUS ATTENDEES FROM INDUSTRY WHO SHARE INSIGHT ABOUT INDUSTRY TRENDS, OFFER FEEDBACK FOR STUDENT PRESENTATIONS, AND PROVIDE VALUABLE CAREER ADVICE." THOMAS PETER FOULKES

Left: Dr. Atcitty from Sandia National Laboratories provides a keynote address on the challenges of renewable energy integration.

- Tutorials on electric aircraft architectures by **Kiruba Sivasubramaniam Haran**, associate professor of electrical and computer engineering at Illinois, and on HVDC microgrid hardware by Dr. **Tomas Modeer**, SCiBreak AB
- A tour of Ameren's state-of-the-art microgrid facility
- Presentations of 34 technical papers and 16 undergraduate posters
- A panel discussion focused on providing career advice for young professionals
- Time for networking at the Illinois-Purdue basketball game

"None of PECI's initiatives would exist without the strong engagement and support from our sponsors," says graduate student and fellow **Thomas Peter Foulkes**, president of the IEEE PES/PELS/IAS graduate student chapter at Illinois and the 2018 IEEE PECI corporate relations co-chair. "PECI is blessed every year to have numerous attendees from industry who share insight about industry trends, offer feedback for student presentations, and provide valuable career advice. PECI's wide variety of professional development and networking opportunities enriched by engagement with industry are the key ingredient to the success of PECI."

The 2019 PECI, which is the tenth anniversary of the conference, will be held February 28 and March 1. The theme will be "A Reliable, Secure, Low-Carbon Energy Future."

For more information on the 2019 PECI, visit

» **peci.ece.illinois.edu**

The PECI conference committee thanks the following organizations for their financial and conference support: The Energy, Power, Control and Networks Program of the National Science Foundation, ComEd, Ameren Illinois, Eaton, Power World Corporation, the IEEE Central Illinois Section, Plexim, and the Power Optimization of Electro-Thermal Systems (POETS) NSF ERC; the committee also thanks Power Affiliate Members: Exelon, G&W Electric, MidAmerican Energy, S&C Electric, Sargent & Lundy, Continental Automotive, and City Water, Light & Power.

ATOP THE POWER RANKINGS

In the most recent report of the Shanghai Academic Ranking of World Universities (ARWU), the University of Illinois placed first in Automation & Control, a one-spot improvement from last year.

The ARWU was first published in 2003 and ranks world universities based on the following objective indicators:

- Number of alumni and staff winning Nobel Prizes and Field Medals
- Number of highly cited researchers selected by Clarivate Analytics
- Number of articles published in journals of *Nature* and *Science*
- Number of articles indexed in Science Citation Index - Expanded and Social Sciences Citation Index
- Per capita performance of the university

The initial purpose of the ARWU was to identify the global standing of top Chinese universities, but now hundreds of U.S. and international universities are part of the rankings and cite them in their campus news, annual reports, or promotional materials. The ARWU has earned a reputation as one of the most influential international rankings of universities, and its methodology is considered to be scientifically sound, stable, and transparent.

STEP UP TO THE MICROPHONE

Graduate student **Jacob Daniel Bryan** knows that ECE 445: Senior Design can be a pressure cooker for undergraduates. As former head teaching assistant, he has helped guide students as they envision and build a working prototype that demonstrates their design skills in a matter of months, a process that can take years in the real world.

Nearly half of the grade for ECE 445 is determined by a demonstration, presentation, and paper that are all due in the last few weeks of class. For those who succeed, it's an exhilarating experience that helps prepare them for a

"I'VE TRIED TO IMPRESS UPON THE STUDENTS THAT, NO MATTER HOW BRILLIANT YOU ARE, IF YOU CAN'T CONVINCE SOMEONE OF THAT BRILLIANCE, IT'S ALL FOR NAUGHT."
JONATHAN MAKELA

Continued »


Jonathan Makela


Jacob Bryan


Ann Bryan


Grace Giorgio

successful career. For those who struggle, however, it can be a whole different story.

Bryan remembers one student who experienced the latter, watching a job offer slip from his grasp when he failed the class. Determined to succeed, however, the student took the course again. This time he achieved much better results, thanks in part to the communication skills he gleaned from Skills for Presenting Engineering and Applied Knowledge (SPEAK).

TECHNICALLY SPEAKING

Engineers SPEAK is a unique collaboration between ECE ILLINOIS and the Department of Communication in the College of Liberal Arts & Sciences that's helping engineering students on the eve of one of the biggest presentations of their undergraduate careers.

"I've tried to impress upon the students that, no matter how brilliant you are, if you can't convince someone of that brilliance, it's all for naught," says ECE ILLINOIS Professor **Jonathan Makela**, who is also the associate dean for undergraduate programs for the College of Engineering and a member of the Engineers SPEAK leadership team. The problem, Makela says, is helping students find the time to develop their communication skills in a curriculum that's already packed.

While students in Senior Design have received some coaching in the past, the assistance came from engineering TAs with no formal training in communication. That failed to move the needle. When faculty decided to reach out to the Department of Communication for help, Jacob Bryan knew just the person to talk to—his wife **Ann Bryan**, a graduate assistant in the department. "She teaches communication, and I'm passionate about engineering," says Jacob. "So, I ended up just kind of dragging her into it, and it bloomed."

With the encouragement of then ECE ILLINOIS Professor **Scott Carney,** Ann recruited additional communications teaching assistants. Together they began providing students with the help they needed to improve their presentations—teaching them how to stand, how to breathe, how to eliminate verbal fillers, and why all of those details mattered. With their expert guidance, the students saw big results.

"The semester prior to these workshops, students had sort of the standard bell curve for their presentation scores," says Jacob. "The first semester we did this workshop, everyone was just slammed on the high end."

It was no small change. Average scores jumped by an astounding 50 percent, necessitating a change in the grading rubric. There was just one problem. All the teaching assistants from the Department of Communication were volunteering their time.

"We had all of these communications people helping us out of the goodness of their hearts," says Ann. So Carney led the effort to pursue a Strategic Instructional Innovations Program (SIIP) grant from the College of Engineering. Others helped as well, including **Grace Giorgio**, a course director in the Department of Communication who was already looking for a way for the departments to connect.

For Giorgio, the idea came a few years earlier when she heard an engineering dean say that students needed strong communications skills in order to lead. "I just remember cataloging that into my brain going, there could be a collaboration between communication and engineering. And I would like to see that happen." With Giorgio on board as course director, they soon received the grant, and Engineers SPEAK became a funded program.

A FRIENDLY AUDIENCE

While some things have changed since they started, the basic process remains the same. Students sign up as a group for the required clinic, and then each member of the group makes a five-minute presentation to a small team of teaching assistants from ECE ILLINOIS and Communication who offer their feedback.

Whenever possible, the team includes both a teaching assistant from CMN 101, which focuses on the basics of public speaking like breathing, and a TA from CMN 111/112, which concentrates more on critical thinking and argument. This gives the students the benefit of both perspectives. There are no grades and no faculty present, providing students with a chance to present to a friendly audience focused on their success.

Not every student arrives with the best frame of mind. "Some of the teams' demos have literally failed days ago," says Ann. "The biggest portion of their grade just collapsed, so they're in a very vulnerable position." For these students, the team often acts as cheerleaders, helping them get excited about their work and learning ways to successfully talk about failure.

Another thing they emphasize is problem solving. "It's the essential thing in 445 that we're trying to get them to think about," says Jacob.

"We can challenge them a little bit on that," says Ann, "and it forces them to clarify their thoughts."

Both Jacob and Ann have been impressed by the students' ability to assimilate what they learn. Groups that present later in the clinic often make adjustments based on the feedback of those who've gone before, and Jacob says he often sees students do things in the final presentations he knows they were taught.

Of course, students aren't the only ones to benefit from the interdepartmental collaboration. "For the Comm TAs, it's a very valuable experience, because they have the opportunity to interact with engineering students, talking about technical aspects of what they're doing," says Makela.

Giorgio agrees, adding that having that experience on a CV can really open doors. For Ann, there's another benefit. "It's interesting to translate what we do to a totally different audience and talk about technical presentations," she says, adding that the exercise has enhanced her ability to teach communications students.

SUCCESS SPEAKS VOLUMES

With their success, the program has expanded, offering clinics for other engineering classes where presentation plays a key role, including senior design courses in the Department of Mechanical and Systems Engineering and the Department of Agricultural and Biological Engineering. The Engineers SPEAK team plans to apply for one additional year of funding from the SIIP grant. After that, they will need to find a more permanent funding source for it to continue.

Makela hopes it will, adding that it serves a unique role for engineering students. "Having it presented in this method where it's still the right people presenting the material to them, but at a time that is convenient and impactful for them, I think, is really the way to go."

Jacob knows of at least one Engineers SPEAK participant who would agree. After initially losing a job offer, Jacob says the student who failed ECE 445 not only passed the second time, he landed his dream job. In a thank you email he later wrote to Carney, the student says the company told him that one of the key reasons they hired him was his ability to communicate technical knowledge, which he attributes directly to Engineers SPEAK.

That's music to the ears of those who've worked hardest to make it happen. "Things like that," Ann says, "make it totally worth it."

John Turner

C3SR

"IBM CAME TO ILLINOIS BECAUSE THEY STARTED TO SEE THAT IN ORDER TO REALLY DEPLOY AI SYSTEMS, THERE WAS NOT ENOUGH COMPUTING POWER IN THEIR CAPACITY TO DO THINGS THEY WANTED TO DO."

WEN-MEI HWU

ARTIFICIAL INTELLIGENCE FOR $2,000

If you responded "What is C³SR?" to this Jeopardy! answer, you'd be right.

Ever since IBM's Watson beat Jeopardy! champions Ken Jennings and Brad Rutter in 2011, the stage has been set for a renaissance of artificial intelligence (AI). And a collaboration between ECE ILLINOIS, CS @ ILLINOIS, and IBM puts the University of Illinois at the forefront of that revival.

The project, known as the **Center for Cognitive Computing Systems Research**, seeks to leverage vast data sets and advances in computing to create useful tools for everything from medicine and education to helping banks manage risks. C³SR is only two years old and already has had some major successes and energized and inspired the ECE and CS students involved.

AI is a process in which computers can make predictions and inferences based on data — natural languages, images and the like — that it has "learned." This is known as machine learning. In these scenarios, computers will be able to not only complete tasks, but to predict and advise humans, by analyzing vast data sets and recognizing patterns within them.

At its simplest, it's when Amazon tells you you'd like a certain book based on your past book-buying history. But at its most complex, cognitive computing (AI) has the potential to help doctors treat patients, banks detect frauds and manage risks, and teachers and students learn more effectively and feel more engaged.

Successful AI requires enormous data sets. Thanks to both exponentially growing data sets (largely from social media and crowdsourcing) and increasing computing power, the time is ripe for AI.

"IBM came to Illinois because they started to see that in order to really deploy AI systems, there was not enough computing power in their capacity to do things they wanted to do. They can't handle big enough data sets," says **Wen-mei W. Hwu**, professor of electrical and computer engineering and director of the C³SR project.

C³SR is an opportunity for Illinois to play to its strengths; Illinois has a long history of building big systems, from ILLIAC to Blue Waters, as well as in developing compiler technologies and systems. IBM is counting on Illinois's expertise, not only in software development but also in hardware and the ability to integrate the two.

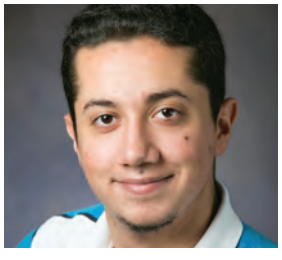
"IBM is always looking for opportunities to advance the state-of-the-art computing through open collaboration," says Dr. **Jinjun Xiong**, IBM's director of C³SR, in explaining the choice of Illinois. "They have expertise across the board and still have a focus on system integration. ...

Continued »

Jinjun Xiong

Wen-mei Hwu

Carl William Pearson



Tarek J. Sakakini

You have to have both those capabilities and also the willingness to knock down barriers."

The "motivating cognitive application," as PhD student **Carl William Pearson** characterizes it, is called the Creative Experiential Learning Advisor, or CELA. The challenge is to harness all the data on the internet to help teachers and students with science-related topics.

For example, imagine a teacher has a hard time finding just the right project for their classroom. If CELA could create a database of STEM education curriculum goals as well as all science experiments, organized by grade or ability, and map those curriculum goals to existing projects, teachers and students alike would benefit. That program also could take into account the students' backgrounds and specific needs. The system also could make use of videos, which would help students stay engaged.

Illinois PhD students **Hongyu Gong** and **Tarek J. Sakakini**, among others, have already made great inroads. Their work has involved defining scientific concepts, gathering a corpus of scientific experiments, and then mapping between the concepts and the projects. Gong, together with her Illinois advisor, **Suma Bhat**, designed an algorithm specific to the nature of text in scientific concepts and scientific projects. The newly designed algorithm achieves the mapping at a performance exceeding existing algorithms.

A key part of the C^{3}SR collaboration is that most Illinois students spend summers at the IBM campus and interact with an IBM mentor on a specific project. IBM made sure students had access to researchers all year long, but summer is a particularly good time for mentors and students to have more focused interactions. There are frequent presentations by IBM employees, and UI students also were encouraged to present their work. This has been life changing for ECE students.

"Hearing the stories of the IBM researchers was inspirational," Sakakini says. There also were ample opportunities to socialize outside of work and have informal conversations. "It really helped me see how research impacts industry and the market. We got exposure and also feedback," he adds.

Indeed PhD student **Cheng Li**, after successfully completing a project on Matrix Factorization on GPU while at IBM, was encouraged by both Xiong and Hwu to find a new project. Together with fellow PhD student **Abdul Majed Dakkak**, Li developed ML ModelScope, an open source distributed platform to help developers in "model experimentation, deployment, and evaluation across hardware infrastructures." This project is so successful it has become the flagship project in C^{3}SR. Li and Dakkak have demonstrated it at IBM booths in major conferences, including the Annual Conference on Neural Information Processing Systems (NIPS), Consumer Electronics Show (CES), and Association for the Advancement of Artificial Intelligence conference (AAAI). This is now Li's major research project, and she continues to work closely with Xiong and others at IBM.

"There was an expert in every field, an entire building of experts … and we were treated as colleagues. Everyone was very supportive and we had lots of freedom," says Pearson. "I feel like what I'm doing is more real."

Also, because the C^{3}SR project is so broad in scope, these students have the opportunity to learn from people working in many different domains. And their input also was greatly appreciated by IBM researchers. Pearson says that C^{3}SR also has had a big impact on campus because the graduate students have become more engaged with the undergraduates in the course of the C^{3}SR projects.

"We are all better for it," says Pearson of the interactions between IBM and ECE.

Deb Aronson

ENABLING TRAFFIC CAMERAS TO CATCH THE SMALLEST DETAILS

Thomas S. Huang

C³SR projects have already had numerous successes, including winning the Smart World NVIDIA AI City Challenge. This challenge, undertaken by labs around the world, sought to engineer "the most effective model for object detection in traffic video." This undertaking required participants to handle huge data sets from traffic videos. The Illinois team was comprised of Professor **Thomas S. Huang** and graduate students **Honghui Shi**, **Zhichao Liu**, **Yuchen Fan**, and **Xinchao Wang.**

Traffic cameras are among the largest generators of vast data sets. The goal was for the computer to be able to distinguish between pedestrians, stationary objects, various types of cars—from small cars to trucks—and to discern the time of day and the color of the traffic light. This is a very difficult project because there are a large number of images, several hundred thousand, and each team had to come up with a system to process and identify all activities and objects.

The first part of the challenge was to annotate almost 1.5 million objects from more than 80 hours of video. The second phase involved building and activating a model to effectively and efficiently track objects from the videos.

These kinds of challenges, including the DARPA self-driving car challenge, provide an efficient way to move a real-world problem forward in a way that grant-making organizations do not, says Wen-Mei W. Hwu, director of the C³SR project.

›PROFESSORS ›AHUJA ›AL-HASSANIEH ›CUNNINGHAM ›GODDARD ›GROSS ›HA ›KREIN ›KUDEKI ›KUMAR ›LIANG ›LOUI ›NICOL ›POPESCU ›ROSENBAUM ›ROY ›SHANBHAG ›SINGER ›SRIKANT ›VARSI

FACULTY AWARDS

NARENDRA AHUJA
Honorary degree of Doctor of the University, University of York

HAITHAM AL-HASSANIEH
NSF CAREER Award

CAN BAYRAM
Dean's Award for Research Excellence, College of Engineering
2018 IEEE Nanotechnology Council Early Career Award
Young Scholar Award, Turkish American Scientists & Scholars Association
Best Paper Award (with PhD student Dicky Liu), International Conference on Compound Semiconductor Manufacturing Technology
Senior Member, Optical Society of America

STEPHEN ALLEN BOPPART
2018 SPIE Startup Challenge Winner
Fellow, Biomedical Engineering Society

KENT D. CHOQUETTE
Best Poster Award, IEEE Photonics Society, 2018 Summer Topicals (Z. Gao)

BRIAN T. CUNNINGHAM
Associate, Center for Advanced Studies
Distinguished Lecturer, IEEE Photonics Society

LYNFORD L. GODDARD
Associate, Center for Advanced Studies
University Scholar, Faculty Scholar Program, University of Illinois System

GEORGE GROSS
Ten Professors to Know in Power Engineering, Online Engineering Programs

PAVAN KUMAR HANUMOLU
Foundations Required for Novel Compute (FRANC) award, DARPA Electronics Resurgence Initiative

WEN-MEI W. HWU
Rose Award for Teaching Excellence, College of Engineering
CGO Test of Time Award (Most Influential Paper), International Symposium on Code Generation and Optimization
IEEE TCuARCH Chair

RALUCA ILIE
Air Force Office of Scientific Research Young Investigator Program
Best Student Presentation Award (Mei-Yun Lin, Yu Huang), 2018 Geospace Environment Modeling Workshop

DANIEL S. KATZ
Fellow, Better Scientific Software, U.S. Department of Energy, inaugural class

NAM SUNG KIM
Honorable Mention, 2017 IEEE Micro Top Pick Paper

PHILIP T. KREIN
Fellow, National Academy of Inventors

ETHAN KUDEKI
George Anner Excellence in Undergraduate Teaching Award

RAKESH KUMAR
IEEE MICRO Top Picks Award
Stanley H. Pierce Faculty Award, College of Engineering
Mahatma Gandhi Pravasi Samman Award, NRI Welfare Society of India
Engineering Council Outstanding Advising Award

ZHI-PEI LIANG
Distinguished Reviewer, Magnetic Resonance in Medicine
Founders Series Lecture Speaker, Institute of Imaging Science, Vanderbilt University
Visiting Professorship, Cleveland Clinic Foundation

›BAYRAM ›BOPPART ›CHOQUETTE ›HWU ›ILIE ›KATZ ›KIM ›LU ›MILENKOVIC ›MITRA ›MOULIN ›SANDERS ›SCHUTT-AINÉ ›WONG ›ZHU

MICHAEL C. LOUI
Fellow, American Society for Engineering Education

YI LU
ACM SIGMETRICS Test of Time Award

OLGICA MILENKOVIC
Fellow, IEEE

SAYAN MITRA
Dean's Award for Research Excellence, College of Engineering

PIERRE MOULIN
ECE Ronald W. Pratt Faculty Outstanding Teaching Award

DAVID M. NICOL
Editor in Chief for *IEEE Security & Privacy*, IEEE Computer Society

GABRIEL POPESCU
2018 Microscopy Today Innovation Award

ELYSE ROSENBAUM
Associate, Center for Advanced Studies

ROMIT ROY CHOUDHURY
2017 Google Faculty Award

WILLIAM H. SANDERS
Executive Officer Distinguished Leadership Award, Office of the Provost

JOSÉ E. SCHUTT-AINÉ
Best Symposium Paper Award, 2017 IEEE Electrical Design of Advanced Packaging and Systems Symposium (with Andreas Cangellaris and Xu Chen)

NARESH R. SHANBHAG
2018 SIA-SRC University Researcher Award
Foundations Required for Novel Compute (FRANC) award, DARPA Electronics Resurgence Initiative
Best Paper Award, 2018 IEEE International Symposium on Circuits and Systems

ANDREW SINGER
Associate Dean of Innovation and Entrepreneurship, College of Engineering
Amazon Alexa Innovation Fellowship

R. SRIKANT
IEEE Koji Kobayashi Computers and Communications Award
Best Publication in Applied Probability, INFORMS

LAV R. VARSHNEY
Beckman Fellow, Center for Advanced Studies
Selected Participant, National Academies 2017 Arab-American Frontiers of Science, Engineering, and Medicine Symposium

MARTIN D.F. WONG
2017 Distinguished Alumni Educator Award, Department of Computer Science, University of Illinois at Urbana-Champaign
Fellow, ACM

WENJUAN ZHU
IBM Faculty Award

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GREAT ENGINEERS & GREAT CONVERSATION

ECE ILLINOIS alumni from the last six decades gathered to renew old acquaintances and forge new connections at a networking event at Google's corporate headquarters this summer.

It was a time for attendees to reminisce about time on campus, share stories about current work and future ventures, and hear about some of our exciting initiatives and student success stories, including how the best and brightest are able to be part of ECE ILLINOIS because of the Engineering Visionary Scholarship Initiative.

The event brought together great engineers, great leaders, great conversations, and great support for future ECE ILLINOIS students.

For more information about upcoming alumni events, visit
» ece.illinois.edu/alumni

DISCOVERY PARTNERS NETWORK POSITIONS ILLINOIS TO LEAD THE INNOVATION REVOLUTION

"WITH THEIR TREMENDOUS SCALE AND THE U OF I SYSTEM'S RESEARCH KNOW-HOW AS AN ANCHOR, DPI AND IIN CAN FOSTER BREAKTHROUGH DISCOVERY THAT WILL NOT JUST RIVAL SILICON VALLEY, BUT LEAPFROG IT."
TIMOTHY KILLEEN

A new interdisciplinary research institute led by the University of Illinois System will bring world-class research faculty and staff to Chicago to work side-by-side with students and businesses. Discovery Partners Institute (DPI) will serve not just Chicago, but the entire state, through the Illinois Innovation Network (IIN), a set of connected hubs located in communities across the state.

The university has long been a springboard for innovation, with a legacy of discovery. DPI and IIN expand the innovation infrastructure to an unprecedented scale.

"DPI will be home to literally hundreds of world-class researchers—top faculty from across our system and new ones we plan to hire," said University of Illinois President **Timothy Killeen** at the announcement of the institute in October 2017.

"They will work with thousands of students every year, with countless businesses large and small, and with entrepreneurs and investors in the heart of Chicago, a truly global city that helps drive the economic fortunes of our state and the Midwest. Through IIN, the research center will connect with satellite hubs across Illinois, sharing its intellectual power with regional academic and business partners to impact communities all over our state."

DPI will focus on strengthening the future of Illinois and the global landscape through innovation and collaboration and will address global matters through four key focus areas: Computing & Data, Food & Agriculture, Health & Wellness, and Environment & Water.

"With their tremendous scale and the U of I System's research know-how as an anchor, DPI and IIN can foster breakthrough discovery that will not just rival Silicon Valley, but leapfrog it," said Killeen. "They will make Illinois home to the next-generation job opportunities that keep our best and brightest here after they graduate, using their talents to build our tax base and lift our communities."

William H. Sanders, former ECE ILLINOIS department head and Donald Biggar Willett Professor of Engineering, was named interim director of DPI in August.

NEW ENGINEERING EDUCATIONAL INITIATIVES RECEIVE FUNDING

Three proposals from the College of Engineering have been selected for funding by the university's Investment for Growth program, an initiative that focuses on advancing the university's missions of education, research, and public engagement.

The three Engineering proposals funded include: an expansion of the existing **Engineering City Scholars Program**, which matches undergraduates with Chicago-based internships; the creation of a **blended learning option** for undergraduate degree programs, allowing for off-campus career-building experiences; and the establishment of the **Center for Autonomy**, which aims to advance efforts in artificial intelligence, digital hardware, communication networks, and information systems.

A collaboration between Engineering and the College of ACES, the **Center for Smart Agriculture**, has also been funded. It will strengthen research, industrial outreach, and community education in agricultural sciences.

UNIVERSITY ANNOUNCES FREE TUITION PROGRAM

Beginning in fall 2019, the University of Illinois will offer eight semesters of free tuition and fees to any qualified in-state student whose household income is below $61,000 a year, the current state household median income. Transfer students will be offered up to six semesters of tuition and fees.

The program, called **Illinois Commitment**, is aimed at attracting talented low- to moderate-income students as well as first-generation college students.

For more information on Illinois Commitment, visit » admissions.illinois.edu.

CAMPUS TO ESTABLISH NEW DATA SCIENCE CENTER

Plans for a new statewide innovation network to accelerate job creation and economic growth include building a world-class center devoted to the fast-growing field of data science.

The data science center will be created by replacing the university's Illini Hall with a 60,000- to 80,000-square-foot research and classroom facility. It will be funded in part with a portion of the $500 million in state capital funding approved last spring to launch the Discovery Partners Institute (DPI) and Illinois Innovation Network (IIN). The university will contribute to the project.

"The DPI is a $500 million vote of confidence and support from our state leaders in this university's ability to be the most important driver of innovation and economic growth in our state," says Chancellor Robert J. Jones. "And we're extremely excited that one of the inaugural investments recognizes the unmatched expertise in data sciences and advanced analytics we have at the University of Illinois at Urbana-Champaign."

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TAKING ON A CHALLENGE

When Katherine Coles (BSEE'09) was a junior, challenging financial circumstances forced her to work two jobs and become a part-time student just to stay at Illinois. But a Kirkwood Scholarship for Women in Engineering changed all that.

The same week she got the news about the scholarship, Katherine enrolled as a full-time student and cut back her hours at work. "Receiving the Kirkwood Scholarship allowed me to finish school in a reasonable timeline, almost debt-free," she says.

Katherine is committed to helping other students do the same by contributing to the same scholarship fund that made her education possible. And she's doing it by taking on another challenge—the Grainger Matching Challenge.

Taking advantage of an additional matching incentive her employer offered on Giving Tuesday allowed Katherine to "triple what my contribution would have been alone, and that has felt so meaningful."

Challenge accepted.

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