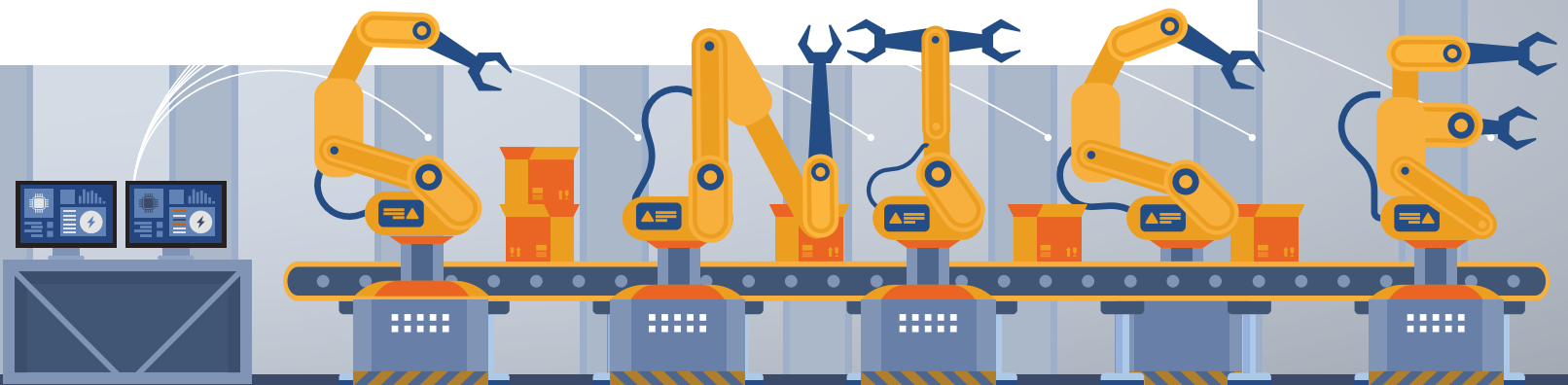


# CONNECT

## \$100M C-NICE Center launched at Illinois



# Contents

- 4** Alumni features
- 5** CSL welcomes four new faculty members
- 6** Faculty highlights
- 8** \$100M C-NICE Center launched at Illinois
- 10** Researchers develop tools to aid in Alzheimer's diagnosis and prognosis
- 12** Announcing the Grainger College of Engineering
- 13** CSL research team introduces unique wearable, audio data-set
- 14** CSL assistant professor helps establish bee-identifying limits
- 15** High school senior develops new cryptocurrency protocol at CSL
- 15** National cybersecurity/resiliency celebrations

## CONNECT

FALL 2019

### COORDINATED SCIENCE LAB

Grainger College of  
Engineering  
University of Illinois at  
Urbana-Champaign

[csl.illinois.edu](http://csl.illinois.edu)

### MANAGING EDITOR

Kim Gudeman

### CONTRIBUTING WRITERS

Kim Gudeman

Allison Arp

### DESIGN

Wes Moore

**Comments and suggestions  
are welcome!**

Please send them to  
[kgudeman@illinois.edu](mailto:kgudeman@illinois.edu)



## Director's Message | Klara Nahrstedt

Earlier this fall, CSL, along with the Grainger College of Engineering, announced the launch of the \$100 million Center for Networked Intelligent Components and Environments (C-NICE). The Center is a partnership between Illinois and Foxconn Interconnect Technology (FIT) to develop smart, reconfigurable technology for smart environments.

C-NICE is a prime example of the mutually valuable relationships that CSL enjoys with industry. While industry connections have always been a hallmark of CSL, we have systematically cultivated collaborations with a variety of companies over the past five years, with the goal of providing real-world solutions in many fields.

Such collaborations include the Center for Cognitive Computing Systems Research, led by Professor Wen-mei Hwu, which provides opportunities for Illinois and IBM to partner on projects in machine learning, embedded systems, natural language processing, and end-to-end computing. Many other CSL faculty have enjoyed long and fruitful relationships with IBM, and there has been a steady stream of student placements there and at other companies.

CSL's collaborations often go beyond research. Microsoft, which has provided gifts and grants to numerous researchers, is in its third year of serving as the primary gold sponsor of the CSL Student Conference. The company supplies the Conference's keynote speaker and a rotating list of guests who have helped students understand industry grand challenges.

Such connections have allowed CSL and companies to better understand each other and develop a common cause. As a result, CSL has increased its applied and fundamental research output.

As we continue to build such relationships, we seek to make CSL an even more attractive partner for industry. Companies are increasingly investing in universities that are themselves investing in diversity. That has long been a goal of CSL's, as we work to cultivate women in engineering, including faculty, graduate students, and postdocs. Furthermore, we offer development, networking, and recognition opportunities for diverse groups of graduate students and postdocs through activities such as the CSL Information talks, the weekly Social Hour, the monthly Video-of-the-Month award, and the annual CSL PhD Thesis Award.

I am pleased to see our relationships with industry grow, and look forward to more rewarding collaborations in the future.

# ALUMNI FEATURES



## CSL alum at the top of his field

### Krishna Ratakonda

After completing his Ph.D. in 1998, Krishna Ratakonda has worked his way up the ranks at the IBM T.J. Watson Research Center in New York, eventually becoming an IBM Fellow in April 2014. In 2017 he became the Chief Technology Officer for IBM's blockchain solutions arm. He credits the University of Illinois for giving him a good foundation for his career.

"Illinois has a fantastic engineering program," said Ratakonda. "Many of the professors were, and still are, leading experts in their areas of research, so it was great learning from them what practical techniques you could use and how to apply them."

Some of the research that Ratakonda recalls working on involved autonomous driving, even in the '90s.

"We were pushing the boundaries of computer vision," he said. "The fundamental change in computational ability has brought many of these things that were in their prototype and infancy stage in the '90s to reality over the last couple decades. Many of the things I learned at Illinois I've been able to see grow, change, and become practical."

The need to adapt to change was a piece of wisdom Ratakonda received from his advisory committee – one he wants to pass along to current CSL students.

"Prepare to change," he said. "Whatever you are doing currently will not be of much interest 10 years from now, so unless you keep changing with the new trends and new ways technology is evolving, you'll be left out."



## Alum built foundation for career in autonomy at CSL

### Bilal Mehdi

CSL alum Bilal Mehdi is helping to keep GM at the forefront of autonomous technology by developing technology that will help pave the way for the next generation of self-driving cars.

Mehdi joined GM after graduating from Illinois with a Ph.D. in mechanical engineering in 2017. As part of his PhD work, he had an internship with the auto manufacturer. That experience introduced him to GM, but he was already very familiar with autonomous vehicles, thanks to his PhD research. He worked on collision avoidance and trajectory planning for small groups of UAVs under his adviser Naira Hovakimyan. Although the applications of UAVs and self-driving cars are different, they deal with similar underlying problems.

"The mathematical problems at GM are similar to those I worked on during my PhD," Mehdi explained. "CSL gave me a strong foundation in research, but also exposed me to working on real, world prototypes rather than just doing math."

While at CSL, Mehdi flew UAVs and completed difficult practical projects whose goals could have been achieved more easily with a simulation. However, understanding the real-world challenges that can come up during implementation is one of the experiences he credits with giving him transferrable job skills.

For current students looking to pursue a career in industry, Mehdi has two pieces of advice.

"If someone is interested in pursuing a career in a certain industry, it is helpful if their thesis topic is related to that technology area," Mehdi said. "Building industry connections is also very important, and internships can help with this."

# CSL welcomes four new faculty members

This semester CSL welcomed four new faculty members in the areas of electrical and computer engineering (ECE) and computer science (CS). Read more below about their backgrounds, and what they hope to accomplish at CSL.



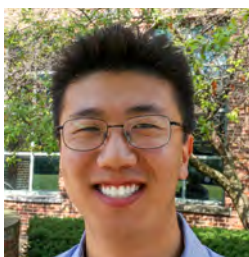
**Saurabh Gupta** Joined the University of Illinois after working as a research scientist at Facebook AI Research in Pittsburgh. Before this, he received a Ph.D. in computer science from the University of California, Berkeley. He is interested in artificial intelligence and wants to understand the interplay between computer vision and robotics. Gupta is an assistant professor in electrical and computer engineering with an affiliate appointment in computer sciences



**Radhika Mittal** Prior to joining ECE as an assistant professor, Mittal was a postdoc at the Massachusetts Institute of Technology (MIT). She received her Ph.D. in computer science from the University of California, Berkeley. Mittal is interested in computer systems and networking, and her research primarily focuses on improving the performance and manageability of networked systems.



**Shaloo Rakheja** Previously an assistant professor at New York University (NYU), Rakheja joined the ECE department as an assistant professor this fall. Prior to her time at NYU, Rakheja was a postdoc at MIT. She received her Ph.D. in electrical and computer engineering from the Georgia Institute of Technology. Rakheja's research aims to connect the physics of nanoscale devices to their applications in energy-efficient computing.



**Richard Yi Zhang** Zhang joined the ECE department as an assistant professor after completing a postdoc at the University of California, Berkeley in industrial engineering and operations research. He received his Ph.D. in electrical engineering and computer science from MIT. Zhang's research focuses include safety-critical guarantees for optimization and machine learning, power system optimization, and computational design of power magnetics.

# FACULTY HIGHLIGHTS



## **Hajek named ECE Department Head**

CSL Professor Bruce Hajek, who is the Leonard C. and Mary Lou Hoeft Endowed Chair in Engineering, an internationally renowned expert in the field of communications networks, and a 40-year veteran of the Grainger College of Engineering faculty, has been named the new head of the Department of Electrical and Computer Engineering.



## **Karahalios chosen as University Scholar**

CSL and Computer Science Professor Karrie Karahalios was chosen as a 2019 University Scholar. The designation recognizes faculty excellence and is one of the most prestigious honors the university bestows. Karahalios hopes to use the funding in part to advance her work related to autism.



## **Amato honored for robotics leadership**

CSL Professor and Illinois Computer Science Department Head Nancy Amato was one of the three recipients of this year's IEEE RAS George Saridis Leadership Award in Robotics and Automation from the IEEE Robotics and Automation Society.



## **Campbell retires, legacy remains**

After 43 years at the University of Illinois, CSL and Computer Science Professor Roy Campbell retired, leaving a legacy of innovation and leadership. Campbell's service in his roles at Illinois – teacher, researcher, administrator, and builder of bridges beyond the department – is deeply appreciated by those who worked with him.

# FACULTY HIGHLIGHTS



## **Leburton receives Serendipity Award**

CSL and ECE Professor Jean-Pierre Leburton was honored with the prestigious Collaborative Conference on Materials Research (CCMR) Serendipity Award. The recognition honors researchers who have published more than 100 Science Citation Index papers. Leburton went above and beyond the requirements, publishing more than 300 papers.



## **Warnow's paper honored for influence**

A paper CSL and Computer Science Professor Tandy Warnow co-wrote in 2005, "Perfect Phylogenetic Networks: A New Methodology for Reconstructing the Evolutionary History of Natural Languages," has been selected for inclusion in Volume 3 of The Best of Language, a compilation of the best articles published by the Journal of the Linguistic Society of America between 1986 and 2016.



## **Shanbhag presents at prestigious ERI Summit**

Started in 2017, the Electronics Resurgence Initiative (ERI) is a five-year, \$1.5 billion investment in defense electronic systems by the Defense Advanced Research Projects Agency (DARPA). Each year, leading researchers are invited to share their research at an annual summit. This summer, CSL and ECE Professor Naresh Shanbhag was among the invited presenters.

# \$100 million Center for Networked Intelligent Components and Environments to drive smart, reconfigurable technologies

The University of Illinois at Urbana-Champaign's Grainger College of Engineering and Foxconn Interconnect Technology (FIT) have partnered on a new \$100 million Center for Networked Intelligent Components and Environments (C-NICE) to be housed at CSL.



**PLACID FERREIRA**

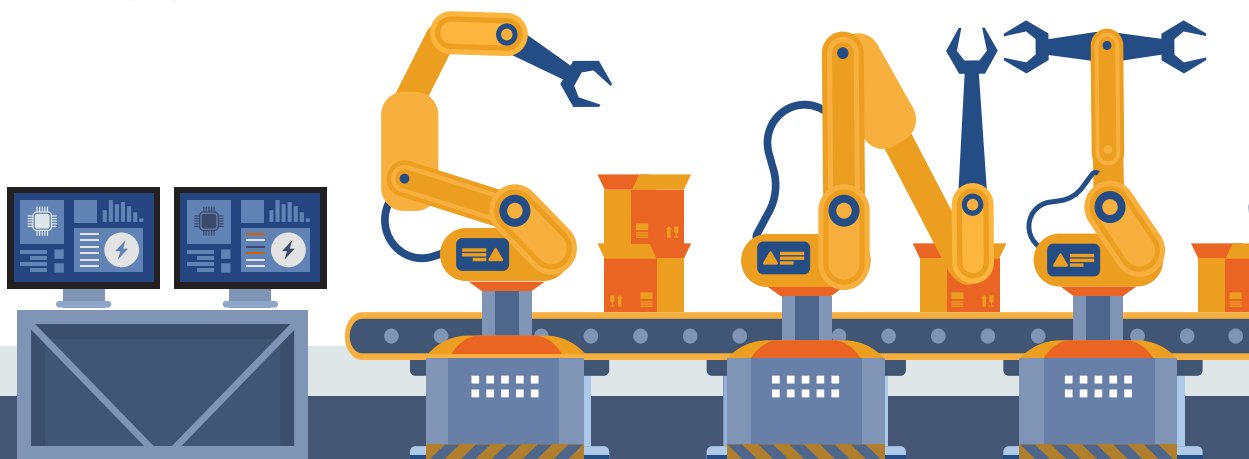
The center will serve as a global hub for the smart, reconfigurable technology that will drive the manufacturing plants, medical environments, autonomous vehicles and smart homes of the future. Placid Ferreira, a professor of Mechanical Science and Engineering, will be C-NICE's founding director.

C-NICE will be supported by a \$50 million, 10-year commitment from FIT to fund programs and research, the first of its kind for FIT. The University of Illinois at Urbana-Champaign, meanwhile, will partner with the Discovery Partners Institute (DPI) and Illinois Innovation Network (IIN) —

statewide initiatives led by the U of I System to foster discovery and innovation—to invest \$50 million to expand facilities to house the C-NICE center and research infrastructure and to hire faculty to advance the research and translational efforts.

Collaborative teams made up of researchers from FIT and the University of Illinois will work together on a broad array of projects, selected and funded on an annual basis, as part of C-NICE.

“I’ve seen the preliminary proposals that were submitted as well as the interactions our faculty have had with FIT technical leads, and there is an excitement about being able to innovate and address real issues,” said Normand Paquin, CSL associate director for research. “From smart manufacturing to smart homes and sensor fusion projects, there are a lot of ideas that could really have a significant impact on our partner FIT.”

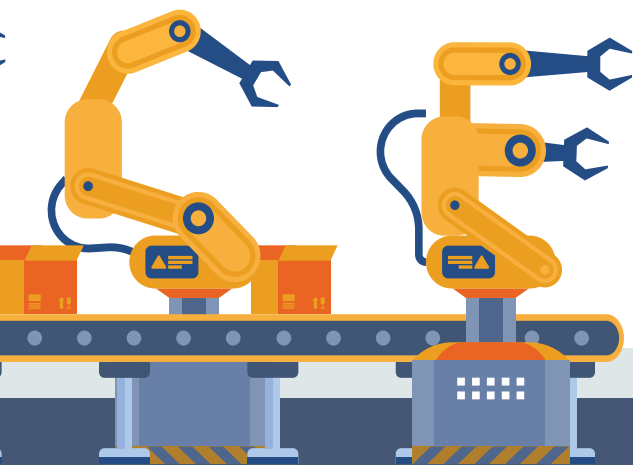






Potential projects include ones designed to advance aspects of FIT’s core businesses as a high, precision smart manufacturing leader to smart home sensors and sensor fusion for consumers, autonomous vehicles, and medical environments.

The first set of projects, with team members from FIT and Grainger Engineering expected to begin in December 2019, will include the development of new measurement techniques for nanoscale components, new methods for capturing and curating manufacturing data, safe robot-human interaction paradigms, and new sensors and sensor data-processing techniques.



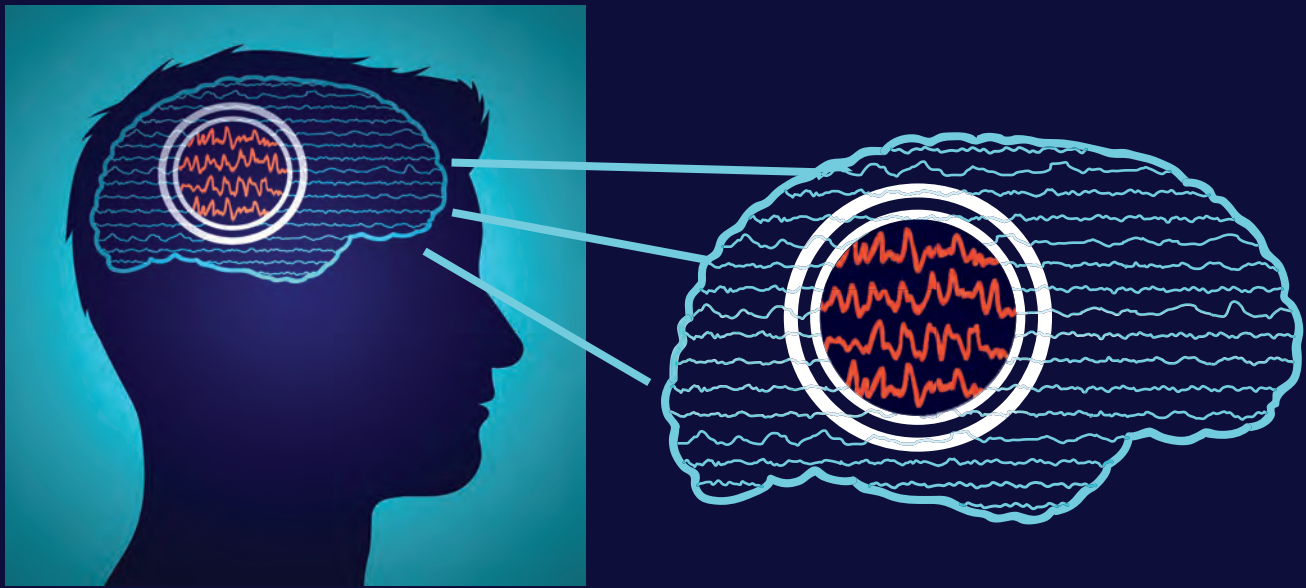
Future projects could include development of precision components, such as electronic and optoelectronic connectors (like a network cable or HDMI cable), antennas (like those used in a cell phone), sensors (like those that cars use to park themselves), and parts used in digital cameras. Additional forward-looking projects exploring advances for next-generation communications infrastructure, consumer electronics, and mobile devices for the intelligent, safe environments of the future could be selected.

Paquin believes CSL is the perfect fit for this type of interdisciplinary research center and strategic corporate partnership. In addition to leveraging the expertise within Grainger, CSL, as an interdisciplinary laboratory, is open to and experienced at bringing faculty together from various units.



*Top officials from FIT and Illinois at the signing*

“CSL plays a really special role in that it is an interdisciplinary research unit that excels in providing the support needed for centers like this to succeed,” said Paquin. “At its heart this center (C-NICE) is a vision for how cyberphysical systems are set to be transformed by innovations in computing technologies, network technologies, data science and processing algorithms. This aligns with the unique capabilities of the experts we have in CSL. There are not many academic research entities that can do what CSL can do.”



## CSL researchers develop tools to aid in Alzheimer's diagnosis and prognosis

Alzheimer's Disease has long stumped the medical community. Even now, researchers aren't sure how it evolves or who is at risk for developing it. A team of CSL researchers, led by Ravishankar Iyer, are working to create tools that could help improve the diagnosis of the illness and produce more accurate prognoses.

"Alzheimer's is reaching epidemic proportions," said Yoga Varatharajah, a CSL graduate student. "There's no cure and a lot of unknowns in the disease pathology."

Varatharajah and his peers in Iyer's research group are trying to unlock some of the mysteries of Alzheimer's. The group is working on developing a toolset that can predict the progression of the disease, and help diagnose a patient's brain health, an early indicator of the disease. The group recently had a paper discussing this work published in Nature's Scientific Reports and has had a second paper accepted in IEEE Bioinformatics and Biomedicine for publication later this fall.

Both studies have used machine learning methods to analyze dozens of prior studies with thousands of data points. For the research published in Scientific Reports, the team's prognosis work was based on a machine learning method for analyzing neuroimaging, spinal fluid, and genetic variables to predict a patient's progression.

"This paper looked at prognosis, primarily on predicting short-term Alzheimer's disease progression," said Varatharajah, an electrical and computer engineering (ECE) student. "There is a continuum for the disease: normal, mild cognitive impairment, and dementia. We can predict those people in the second stage who will go to the third stage in the next two years with 93% accuracy."

They are also working on a diagnostic tool that analyzes brain health using MRI images. The IEEE paper written by Varatharajah, Krishnakant Saboo, and Chang Hu outlines a method of using an MRI image to predict a brain's medical "age," which isn't its chronological age, but the age it appears to be when compared to normally aging brains. If a patient's brain is "older" than his or her chronological age, that signals a problem in overall brain health.



Yoga Varatharajah



Krishnakant Saboo



Ravishankar K. Iyer

At present, a diagnosis can be confirmed only after a patient has passed away.

“The gold standard diagnosis is only done using post-mortem pathology, so you have to take the brain tissue, run an analysis, and then determine this person had dementia,” said Saboo, also an ECE student. “There are ways to approximate the level of their cognition, but our research is focused on developing an objective method to come up with diagnosis and prognosis tools based on measures directly from the brain, like imaging and genetic measures.”

Data for both projects were collected from publicly available datasets, through a collaboration with the Aging and Dementia Imaging Lab at the Mayo Clinic. In partnering with neurologists and neuroscientists from Mayo, the group is developing domain-based artificial intelligence models that have a better chance of early detection of the disease.

“Alzheimer’s is a complex disease with significant heterogeneity seen across patients. The Mayo-Illinois collaboration leverages the AI strengths of Illinois to understand this complexity and further the understanding of mechanisms of Alzheimer’s,” said Dr. Prashanthi Vemuri of Mayo Clinic. “The work published by these researchers showcases how machine learning can be applied to identify individuals at risk of developing dementia in near term, which has a significant public health impact.”

Replication is the next step for the researchers. Varatharajah plans to replicate his work in prognosis prediction with larger groups of patients to validate the findings and generalize the model to more people. Saboo and Hu intend to expand their work to see if they can determine which clinical factors most affect cognition, in order to improve treatments that could slow cognitive decline.

“Since there is no treatment for the disease, these tools can help patients know when to undergo counseling, for example,” said Varatharajah. “Additionally, extensive research is currently being done to find new therapeutic options to treat Alzheimer’s and we believe our techniques will help identify the patients who would most likely benefit from the new therapies.”

Varatharajah and several of the other students came to the issue of Alzheimer’s while working on a DARPA project involving the cognition of epilepsy patients. They are only a few of the students in Iyer’s group working to improve the future of healthcare.

“Working with our Mayo collaborators, Yoga, Saboo, and Chang, along with other students, are working to improve the lives of patients suffering from cognitive problems,” said Iyer. “Through our efforts, and partnerships with medical providers like Mayo Clinic, there is great potential for breakthroughs in the future.”

# Introducing The Grainger College of Engineering

The University of Illinois at Urbana-Champaign's College of Engineering has become The Grainger College of Engineering, recognizing a new \$100 million gift from The Grainger Foundation and more than \$300 million in total support. The college has been named in recognition of the contributions of The Grainger Foundation to the excellence of the college and in honor of distinguished alumnus William W. Grainger. The Grainger Foundation's total support represents the largest amount ever given to a public university to name a college of engineering, with more than \$200 million provided in the last six years.

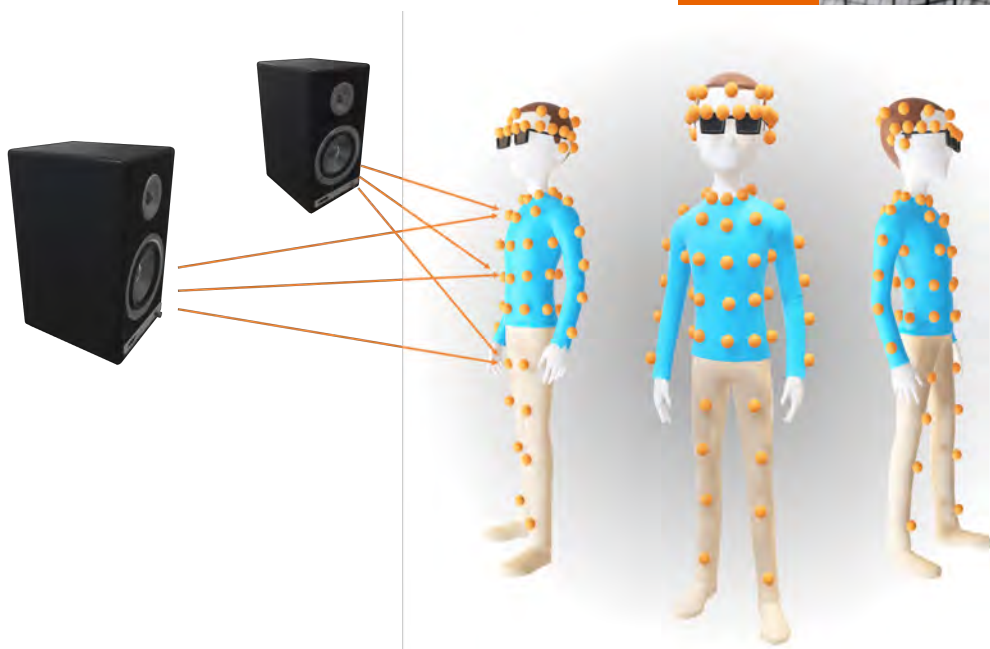
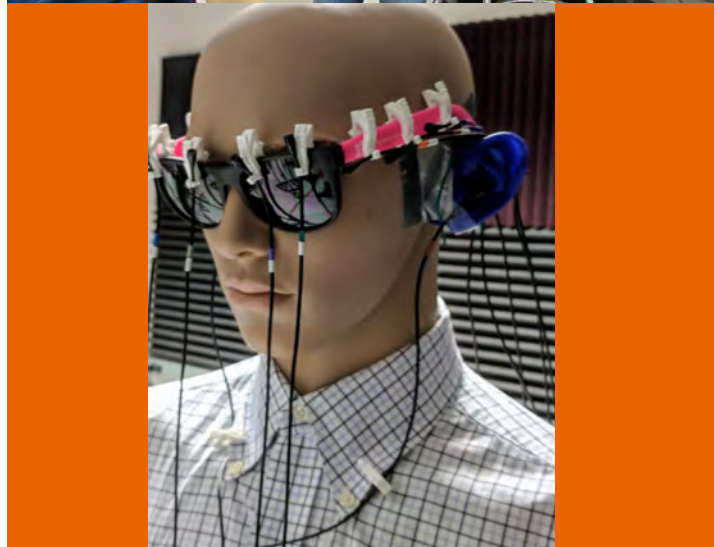


## CSL research team introduces unique wearable-audio dataset

Researchers studying wearable listening technology have a new dataset to use, thanks to CSL graduate student Ryan Corey, his adviser CSL Professor Andrew Singer, and the rest of the CSL Augmented Listening Laboratory.

The first-of-its-kind dataset consists of more than 8,000 acoustic impulse responses measured at 80 different positions on the body. Eighty microphones were tested on five different hat/headphone styles and with six different types of clothing. The sound in the recordings came from 24 directions to simulate noisy crowds.

A few of the potential application areas for the data include augmented reality, speech recognition, and acoustic event detection, among others. Without the dataset created by the CSL team, researchers would have to build their own prototypes and test them, which is time-consuming and expensive. The data collected at CSL are available for free under an open-access license.



# CSL Assistant Professor helps establish bee-identifying limits



Honey bees are important to global plant life, but studying their social behavior is tricky. It is difficult to tell one bee from another due to their small size, busy nature, and lack of distinguishing physical characteristics. Internationally renowned bee expert Gene

Robinson, Institute for Genomic Biology Director and Swanlund Chair at Illinois, came up with the idea of using barcodes to tell bees apart.

CSL Assistant Professor Lav Varshney, and his collaborators at the National University of Singapore established the fundamental limits of barcode design. In other words, they have determined how few symbols have to be in a barcode in order to reliably identify a bee. In addition, the group discovered that joint decoding of the identities of groups of bees was much more accurate than decoding of individual bees.

“This work depends on identifying different bees using barcodes of a given size, given that the pictures of the bees may be noisy or obstructed in various ways,” said Varshney, coauthor of the recently accepted “The Bee-Identification Problem: Bounds on the Error Exponent.” “One can think of images of barcodes as information-bearing signals, observed through noise, and so their optimal design is very much a mathematical problem.”

The ability to determine the fundamental limits of barcodes and identification as a concept can be applied to other research in and out of the animal kingdom, such as using wide area sensors to identify individual penguins or warehouse products labeled with RFID barcodes.



## High school senior develops new cryptocurrency protocol at CSL

In January, CSL Assistant Professor Andrew Miller received an email out of the blue from a 17-year-old high school student in Mumbai, India. What



resulted was a chain of correspondence that ended with high school senior Aman Ladia spending the summer at CSL as one of the youngest research scholars on campus.

“Until now my involvement in blockchain was more from an architectural standpoint,” said Ladia. “With this experience at CSL, I’ve been able to explore complex concepts in far greater technical detail than I would have been able to otherwise.”

During his time at Illinois, Ladia and Miller worked on a key exchange protocol called OPAQUE that was introduced to the cryptography world eight years ago. While the protocol was originally designed to authenticate passwords, Ladia repurposed it and used its core operating principles to create a new protocol called ZeroWallet, which allows users to securely access cryptocurrency wallets using only passwords. So far, the responses from the cryptography community have been positive, with most praising the novelty of the project.



*Aman Ladia (center) joined Andrew Miller (right) and his students this summer for an in-depth research experience at the University of Illinois.*

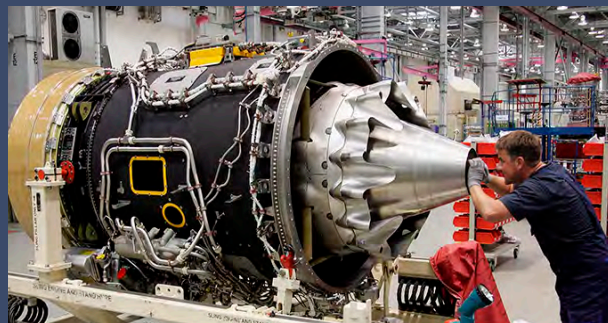
## National Month Celebrations



The Critical Infrastructure Resilience Institute (CIRI) and the Information Trust Institute (ITI) shared the latest research in cybersecurity, and information about how CIRI is developing the tools, processes, and workforce to help keep the nation secure.

Highlights of October included celebrating National Manufacturing Day as well as CIRI’s partnerships with USTRANSCOM, Mt. Hood Community College, and Scriyb. The last two partnerships involve using CIRI’s Dashboard Tool to help train the next generation of cybersecurity professionals and help small businesses meet national standards.

In November CIRI and ITI also celebrated National Critical Infrastructure Security and Resilience Month. This month the focus was on the importance of CIRI’s work to improve mobile security, information, communication, and technology of the supply chain; humanitarian assistance and disaster relief; and the critical infrastructure dependencies of the country.



**I ILLINOIS**

Coordinated Science Laboratory

**GRAINGER COLLEGE OF ENGINEERING**

1308 West Main Street  
Urbana, IL 61801

Non-Profit Org.  
U.S. Postage  
PAID  
Permit No. 75  
Champaign, IL 61820

[csl.illinois.edu](http://csl.illinois.edu)