**Coordinated Science Lab Newsletter**
**ENGINEERING AT ILLINOIS**

# Connect

## CONSTRUCTING A CONNECTED WORLD **PAGE 8**

**FALL 2017**

**ILLINOIS**
CSL | Coordinated Science Lab
**COLLEGE OF ENGINEERING**

# Contents

## Connect

FALL 2017

## Director's Message | Klara Nahrstedt

Technology connects us to other people, to new ideas, to causes that we're passionate about, and even to new opportunities. As the fall semester kicks off, CSL will continue working to improve the connections that transform the way we live, work, and play.

In this issue of *Connect*, you'll read about some of the ways CSL researchers are advancing networks, sensors, security, and applications that make up the Internet of Things. We are working on designing new robots, electric vehicles, health systems, and other technology that are driving the connection between people and technology.

As we seek to grow our research in these critical areas, we continue to add faculty in core areas such as machine learning, robotics, health care systems engineering, and in disciplines such as agricultural engineering, civil engineering, computer science, electrical and computer engineering, industrial engineering, and mechanical engineering, just to name a few. In the past year, we've welcomed Girish Chowdhary (Ag and Bio Engineering, Aero Engineering) and Hae Won Park (Mechanical Science and Engineering) to the Decision & Control group; Niao He (Industrial and Enterprise Systems Engineering) to the Signals, Inference, and Networks group; and Robert Pilawa-Podgurski (ECE) to the Circuits group.

At the same time that we are growing our highly active faculty base, CSL needs to accommodate a growing number of students. This summer, we began a five-year process to renovate and expand student workspace from 8-person offices into 12-person offices. By 2021, we aim to have all the interior student spaces remodeled and ready for occupation.

We're also planning a celebration this fall to commemorate the opening of another new space: the CSL Studio. On October 2, we will hold a Grand Opening Ceremony for the Studio, a new space that houses several interdisciplinary initiatives, including health care systems engineering, cyber security and cyber resilience research, and intelligent robotics. The event will include talks by Engineering Dean Andreas Cangellaris, ECE Dept. Head Bill Sanders (formerly CSL Director), Chair of the CSL Studio Building Committee Geir Dullerud, and other noteworthy speakers.

Later this fall, CSL will co-organize an interdisciplinary science-fiction event called "Speculative Futures @ Illinois," which will be held on campus Nov. 3-4. The event will bridge the gap between the humanities and computer science and engineering with a series of encounters between artists, writers, and technology innovators at the University of Illinois.

Please join us for this event and the CSL Studio Grand Opening Ceremony. And I hope you'll take a few minutes to read more about CSL's Internet of Things research, along with the many interdisciplinary initiatives underway.

### Illinois researchers investigate neuron coding for advances in prosthetics

When we experience a sensory stimulus, such as a baby crying or a bite of pizza, the neurons in our brain fire impulses rapidly to receive and interpret the signal. How these impulses are timed—and how we can replicate it artificially—has been mathematically determined by a team of CSL researchers in the Health Care Engineering Systems Center.

Knowing this code has significant applications in prosthetics and other artificial devices. The team, comprised of senior research scientist Rama Ratnam, CSL alumnus Erik Johnson, and CSL and ECE Professor Doug Jones, is building prosthetics to send signals in the same way our normal organs do so that our brain cannot tell the difference—helping to replace the functionality of what has been lost.



### Sensors embedded in sports equipment could provide real-time analytics to your smartphone

Sports analytics—tracking how fast the ball is moving or how players move across the field— is becoming a key component of how coaches make decisions and fans view games. In an effort to make big data analytics more accessible for the sports industry, CSL researchers, including Computer Science Professor Romit Roy Choudhury and CS PhD student Mahanth Gowda, have utilized Internet of Things (IoT) devices—low-cost sensors and radio—that can be embedded into sports equipment (e.g., balls, rackets, and shoes), as well as in wearable devices.



### Sam Spencer plays on Jeopardy!

Sam Spencer, a CSL and ECE PhD student, got the chance of a lifetime: an opportunity to compete on the Jeopardy! game show. On Friday, May 26, Spencer played on the popular trivia program, placing second. During the course of the game, he was successful on a "True Daily Double," an all-in wager that temporarily catapulted him into the lead, and he was the only contestant to correctly answer the Final Jeopardy question.



### Advanced robotic bat's flight characteristics simulates the real thing

Researchers at the University of Illinois at Urbana-Champaign, led by ECE Professor Seth Hutchinson, and Caltech have developed a self-contained robotic bat—dubbed Bat Bot (B2)—with soft, articulated wings that can mimic the key flight mechanisms of biological bats.

The B2 utilizes a morphing skeleton array and a silicone-based membrane skin that enables the robot to change its articulated structure in mid-air without losing an effective and smooth aerodynamic surface.
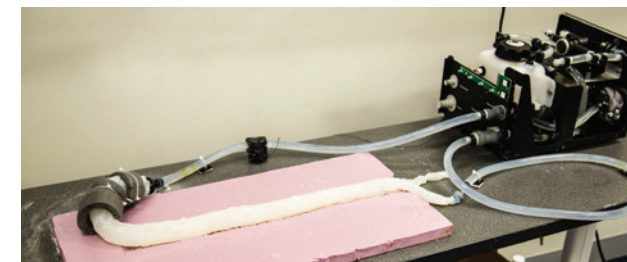


### An artificial oxygenation simulator aims to train surgeons for life and death situations

Researchers at the Health Care Engineering Systems Center, a center supported by the Coordinated Science Lab and the College of Engineering, have developed a training simulator for a rare and risky procedure called extra-corporeal membrane oxygenation (ECMO). The procedure is often a matter of life and death, yet many doctors have never practiced before. Built to resemble the elasticity of arteries and pumped by an artificial heart, the simulator replicates the femoral artery leading to the heart that doctors need to operate on for the surgery.



### Illinois team receives $900,000 grant to build cyber security defenses for renewable energy sources

A team of researchers, led at the University of Illinois at Urbana-Champaign by Research Assistant Professor Sibin Mohan, has been awarded $900,000 from the Department of Energy to produce tools and strategies to protect renewable energy sources, such as electric vehicles, solar cells, and smart appliances, from cybersecurity threats.

The project, in collaboration with United Technologies Research Center and Pacific Northwest National Laboratory, leverages the expertise of cybersecurity professionals at CSL and the Information Trust Institute to address the threats that face emerging energy sources that do not yet have established methods to protect against cyberattacks.

# News Briefs
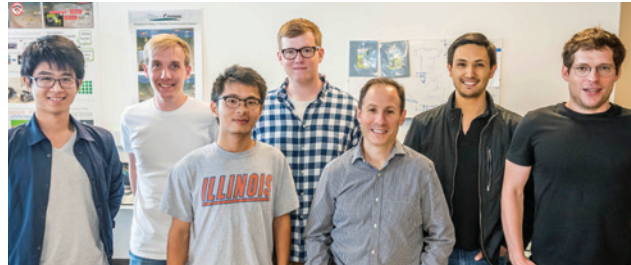


### Startup aims to bring high-speed wireless communications to the subsea industry

OceanComm, a startup founded by CSL alumnus Thomas Riedl and CSL Professor Andrew Singer, is looking to vastly improve our ocean exploration capabilities. The team is developing a new technology that uses ultrasound to wirelessly transmit data at broadband speeds.

OceanComm's wireless underwater modem uses sound waves to send information, similar to how whales and dolphins communicate. Existing wireless underwater modems only transfer about 1 picture a minute, but Ocean-Comm's wireless modem is 1,000 times faster and can live-stream video.

### Robots that can read your mind a breakthrough for manufacturing

Those who wish others could read their minds will enjoy a breakthrough technology out of the lab of CSL's Thenkurussi (Kesh) Kesavadas, the director of the Health Care Engineering Systems Center. Kesavadas and his team have used brain computer interface (BCI) to control a robot.

In its third year of funding, this National Science Foundation project has proven that human experts can look at an object on an assembly line and through sensors from their brain tell a robot to remove a defective object from a conveyor belt.



### CSL researchers design sounds that can be recorded by microphones but inaudible to humans

Microphones, from those in smartphones to hearing aids, are built specifically to hear the human voice—humans can't hear at levels higher than 20 kHz, and microphones max out at around 24 kHz, meaning that microphones only capture the sound we can hear with our ears.

However, PhD student Nirupam Roy and CSL Professors Romit Roy Choudhury and Haitham Hassanieh have designed a sound that is completely inaudible to humans (40 kHz or above) yet is audible to any microphone. This sound could be a white noise that doesn't compete with your conversation but could prevent microphones from sneakily recording your speech.



In the movie *2001: A Space Odyssey*, the computer and main antagonist, HAL, announced it "became operational" in Urbana, Illinois, a nod to the University's history in developing the world's first computers.

# Speculative Futures @ Illinois

**Speculative Futures will take place November 3–4, 2017, on campus and in the community. Among the events planned are:**

- CREATIVE TECH TALK with readings of fiction and discussion of the role of technology in fiction

- TECH TOURS that showcase Illinois innovation past, present and future

- INTERDISCIPLINARY LIGHTNING ROUND PRESENTATIONS for creative artists, writers, and technologists

- SPECULATIVE FICTION BOOK EXHIBIT

- CREATING FOR THE FUTURE WORKSHOP with students grades 6–12 at the Champaign Public Library

Speculative fiction has always relied on visions of technology yet to be realized, spinning fabulous futures that explore the human condition and often offering more than a hint of possible realities yet to come. The University of Illinois at Urbana-Champaign has a special place in this history: Arthur C. Clarke's *2001: A Space Odyssey* celebrated Illinois' role in developing the world's first computers.

Drawing on this legacy, Speculative Futures @ Illinois features a series of encounters between artists, writers, and technology innovators at the University of Illinois.

These activities, which bring creative work and Illinois' signature technology culture into a dialogue, will encourage writers, both present and future, to create stories inspired by the landscape of technological innovation at Illinois.

# Constructing a Connected World

Our society becomes more synced every day. As more physical things—cars, smart refrigerators, and mobile phones—connect to the Internet, there is growing research to advance the technology that drives the connection between all of these devices and objects, known as the Internet of Things (IoT). Dozens of CSL researchers are working to develop sensors, design embedded networks, consider the security and privacy of such systems, and build intelligent robots, among other endeavors, all with the goal of creating a more connected world. Here is a look at a few of those efforts.

## DEMING CHEN
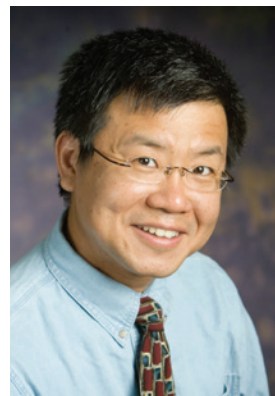
Deming Chen, an associate professor in electrical and computer engineering, works with connected sensors and hardware. He built a start-up called InSpirit IoT, a company that recently collaborated with Illinois researchers to win an IoT competition with a low-cost audio security system. This system includes four microphones and a field-programmable gate array (FPGA), a type of integrated circuit, which has been configured to detect and classify audio sounds. If the system recognizes a suspicious sound, such as gunfire or screaming, it could alert a human operator at a central command station and direct police to a general location using beamforming.
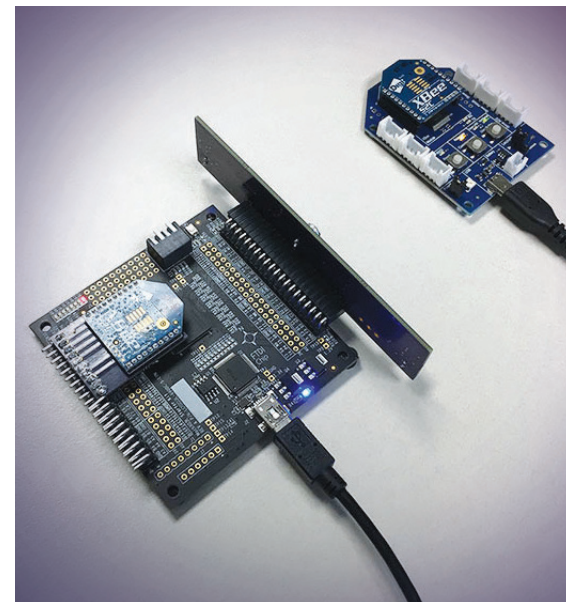
## NAIRA HOVAKIMYAN

Designed by Naira Hovakimyan, unmanned aerial vehicles, from those that fly over crops to look at yield to those that assist the elderly with daily care, are connected to the internet in order to collect, manage, and analyze data. Hovakimyan, a professor in mechanical science and engineering, cofounded IntelinAir, a start-up that uses aerial imagery to analyze fields from above, utilizing IoT to connect to an app for farmers to evaluate. Another project utilizing IoT, ASPIRE, is developing unmanned aerial vehicles (UAVs) that will provide elderly care, like delivering medications and helping with daily chores in a patient's home, helping them to live independently for longer and improving quality of life.

## NIKITA BORISOV

Within our device-driven world, privacy with IoT remains a concern. With everything from our power grid, cars, phones, and thermostats connected to the Internet, cyber-attacks can have a global impact on our society. Nikita Borisov, professor of electrical and computer engineering, has been investigating online and IoT privacy since his PhD at UC Berkeley. He examines computer security and privacy from a network level as it relates to large-scale distributed systems. He also investigates privacy enhancing technologies and building reliable and secure peer-to-peer networks.

> "With everything from our power grid, cars, phones, and thermostats connected to the Internet, cyberattacks can have a global impact on our society."

## MICHAEL BAILEY

When our devices are all connected, a single cyber-attack in one device can cause a lot of damage. Michael Bailey, an electrical and computer engineering professor, strives to make system security more robust to meet the demands of increasing internet usage, as well as build defenses against cyberattacks. His group seeks to understand and create the necessary protocols, software, and services that support the phenomenal growth of IoT. Additionally, with cybercrime now ranking as the FBI's third highest priority, behind counter terrorism and counter espionage, his group works to ensure the security, reliability, availability, and overall trust-worthiness of the nation's information technology and IoT resources.

## KLARA NAHRSTEDT

"Smart" cities—cities of the future that integrate IoT technology to manage the city's assets—will be built on secure and reliable IoT networks. Because of major advances in energy storage, wireless charging, and autonomous driving expected by 2050, there will be tremendous expectations for IoT to acquire, manage, analyze, and secure all digital information around co-dependent resources involved in smart cities. CSL Director Klara Nahrstedt, a professor of computer science, and her research group are working on projects that address the co-dependence and collaboration challenges of connecting all the sectors of a smart city—electric cars, smart grids, automobiles, roads, security systems, and more.

## DAN WORK

Gathering data from connected cars can tell us a lot about traffic management. Civil and Environmental Engineering Assistant Professor Dan Work works on a variety of projects that use IoT to analyze traffic systems. He studies the effect that Hurricane Sandy had on NYC traffic in order to study how evacuation procedures can be deployed efficiently. He also has worked on a system to monitor traffic congestion that can provide valuable, real-time information to police, emergency personnel, and the public with the goal of helping traffic flow more smoothly during major events. Recently, he has been running experiments that show a few self-driving cars interspersed with regular traffic can dramatically improve traffic flow. By carefully controlling the cars' speed, they eliminate stop-and-go driving and improve accident risk and fuel inefficiency.

## MARCO CACCAMO

Embedded systems—the computer systems that work behind-the-scenes to control many devices used today—have developed significantly over the years, and Marco Caccamo, a professor of computer science, has worked on bolstering the software architecture and management of these systems. He's especially focused on real-time operating systems, or systems that process data as it comes in and are often connected to other devices to communicate data. Recently, he's been expanding his scope to investigate the security and robustness problems in the software of unmanned aerial vehicles (UAVs), a device with significant possibilities in IoT research.
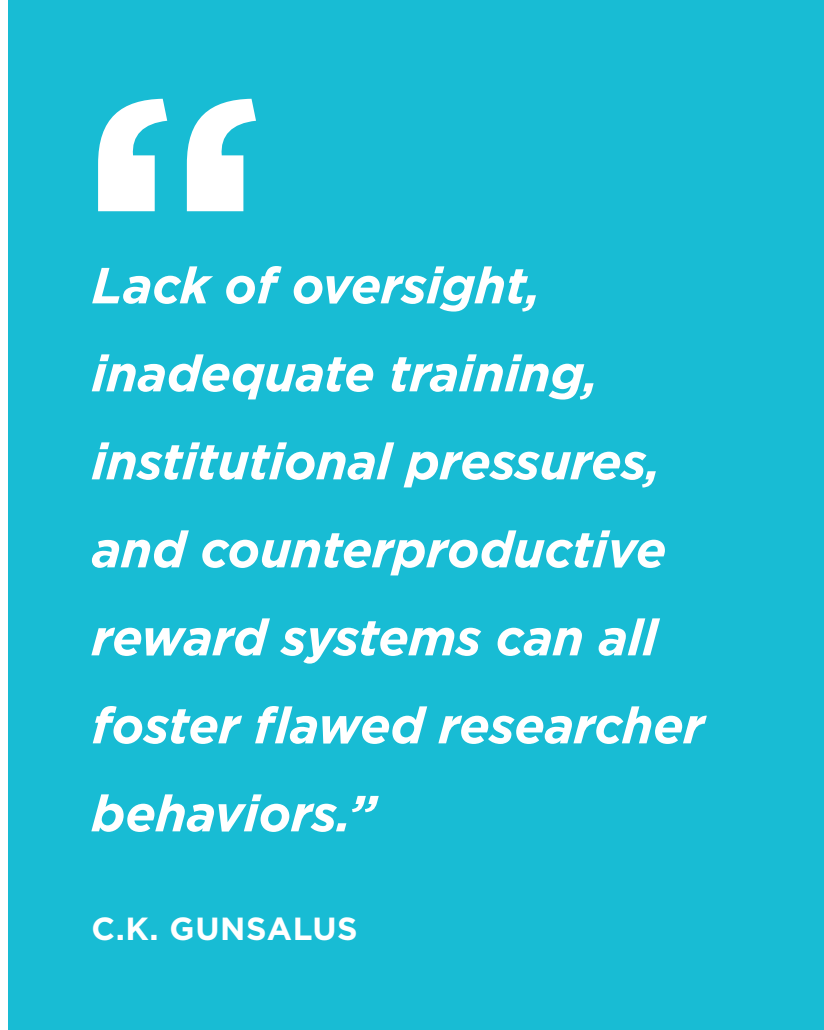
# CSL Researchers Call for Greater Accountability in the Reproducibility of Research

Say that a team of scientists publishes very promising results indicating the development of a treatment that matched chemotherapy to a cancer patient's genetic make-up. The findings promise to transform cancer care, except for one thing: Despite multiple efforts by other scientists, the results cannot be reproduced.

Such a scenario actually happened at Duke University, when it was found in 2010 that a rising young clinician had falsified results about a treatment already being used in clinical trials. The deception was only discovered thanks to the persistent efforts of researchers at other institutions, who had major questions about the science behind the treatment. (Read more about the case at **go.illinois.edu/dukecase**.) The case shows that reproducibility is critical in research, says CSL's C.K. Gunsalus, and not just because of blatant misconduct.

"Science is based on the idea that you make progress and I can take your work and build on it and keep advancing the frontiers of knowledge," said Gunsalus, professor emerita of business and director of the National Center for Professional & Research Ethics at Illinois (**ethicscenter.csl. illinois.edu**). "If your work isn't such that I can reproduce it, I can't build on it. And that costs other researchers time, effort, and money."

Gunsalus presented on the topic of *Reproducibility of Research: Issues and Proposed Remedies* (see **go.illinois.edu/SacklerCKG** to view the video of the presentation), the theme of this spring's prestigious Arthur M. Sackler Colloquia at the National Academy of Sciences in Washington, D.C. The goal of the event, which was co-organized by CSL researcher Victoria Stodden, an associate professor of information science, was to examine why research reproducibility is so difficult to achieve and how to overcome those challenges.

The issue is widespread, impacting fields ranging from the social sciences to the life sciences, with concerns about computational reproducibility mounting. In a 2015 article published in *Science* (**go.illinois.edu/ScienceArticle**), authors claimed that after 270 researchers tried to reproduce the results of 100 published psychology experiments, they were only successful 39 times. A look at leading cancer studies showed the same thing: Only 10-30% of published findings were reproducible, according to reports in Nature and Nature Reviews Drug Discovery.

The assumption might be that irreproducibility is due to flawed research or even potential fraud, but things are not always that simple. Gunsalus attributes these failures to two primary causes: people are complicated and there's a wide

spectrum of things that can go wrong and/or aren't recorded during a research experiment.

"It's far more complicated than oh, we have a bad or sloppy person in this institution," she said. "In the Duke case, the University had so much invested in the project, the lead investigator didn't exercise responsible oversight in the process, and there were many places where the system failed when concerns were raised. Failures arise at both the individual and the institutional levels. We need to do a better job of institutional stewardship in these hard situations in research environments. Lack of oversight, inadequate training, institutional pressures, and counterproductive reward systems can all foster flawed researcher behaviors."

Gunsalus advocates for a three-pronged approach in addressing research ethics issues, which include assessing and benchmarking research environments, incorporating evidence-based practices into Responsible Conduct for Research (RCR) training, and improving academic reward systems and institutional commitment to better respond to breaches of research integrity. She recently served a five-year term on the NAS Committee on Responsible Science, which published its report, *Fostering Integrity in Research* (**go.illinois.edu/report**), this year.

Gunsalus is author of *The Young Professional's Survival Guide*, which tackles potential ethical snares that young professionals may encounter and *The College Administrator's Survival Guide* for academic leaders. NCPRE also recently launched a four-part Coursera specialization, *Professional IQ: Preventing and Solving Problems at Work*, which addresses ethical and leadership development for professionals in various stages of their careers.

> **" Lack of oversight, inadequate training, institutional pressures, and counterproductive reward systems can all foster flawed researcher behaviors."**
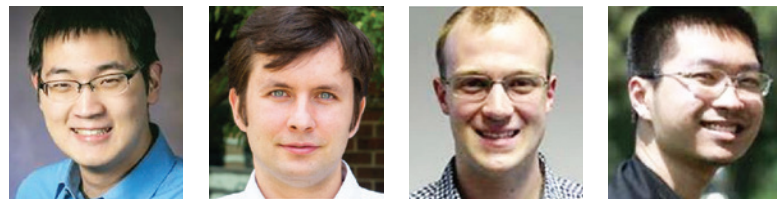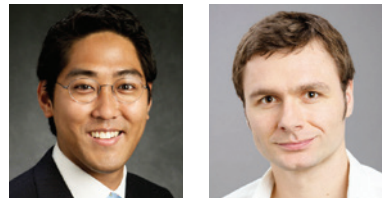>
> **C.K. GUNSALUS**

# Quick Look
## CONGRATULATIONS TO CSL RESEARCHERS

**Rakesh Kumar** and graduate students **Henry Duwe** and **Weidong Ye** win Best Paper Award at ASPLOS 2017 for processor energy efficiency research

Four CSL graduate students selected as Mavis Future Faulty Fellows: **Dong San Choi, Philip E Pare, Jr, Carl William Pearson, and Yingxiang Yang**

**Sewoong Oh** and **Ivan Dokmanić** win 2016 Google Faculty Research Awards

**Haitham Hassanieh** honored with 2016 ACM doctoral dissertation award

**Vikram Adve** named interim department head of Computer Science at Illinois

**Dušan Stipanović** receives Friedrich Wilhelm Bessel Research Award from the Alexander von Humboldt Foundation

**Andrew Singer** named interim director of Siebel Center for Design

# New Software Tool to Help Manufacturing Companies Meet Complex Cyber Security Standards

Researchers at the University of Illinois at Urbana-Champaign have created a new software tool that will help companies, including manufacturers, improve the security and resilience of their cyber systems through standardized risk management processes.

Due to changes in the Dept. of Defense's acquisition regulations (the DFARS), companies who want to manufacture products for the DoD must meet new and heightened cyber security standards established by the National Institute of Standards and Technology (NIST). The deadline for compliance is December 31st of this year.

The Illinois tool, called The Dashboard, is a web-accessible software package that simplifies the process of implementing the new DFARS provisions while simultaneously meeting the NIST Cyber Security Framework (CSF) standard. Thus, users of The Dashboard comply with both standards at once—saving time and effort. Development and testing of The Dashboard is being funded through the Digital Manufacturing and Design Innovation Institute, a Department of Defense-funded next-generation manufacturing research and development center based in Chicago.

"Manufacturing security is of high importance to everyone, but particularly the government," said Randy Sandone, principal investigator of the Dashboard project and executive director of the Critical Infrastructure Resilience Institute at Illinois. "Our goal for this tool is to make it easier for contractors and subcontractors alike to evaluate their security risks and make improvements to their systems so that they not only comply with government requirements but address the growing cyber security threats to the manufacturing sector."

The tool presents a simple, point-and-click interface to the broad range of cybersecurity controls required of management, IT administrators, and individual users to achieve compliance with the DFARS and the CSF. It helps organizations achieve and maintain a standardized, integrated and mature cyber risk management process that is widely recognized for its efficacy in reducing risk and improving the resilience of systems.

The Dashboard will be commercially available this fall. It was developed in Illinois' Information Trust Institute.

While Sandone plans to debut the tool in the manufacturing sector, he says it could be applied to many other areas, such as cyberinsurance, healthcare and maritime petroleum operations.

For cyber insurance, the Dashboard could facilitate the widespread adoption of a standardized cyber risk management process. This, in turn, can help facilitate a more robust cyber insurance market by reducing the burden on underwriters to evaluate a myriad of home-grown cyber risk management processes as they evaluate the underwriting risks of individual insurance policies.

"The NIST framework is the gold standard and this tool will make it easier for any company to achieve and maintain that high level of cyber security protection," Sandone said.
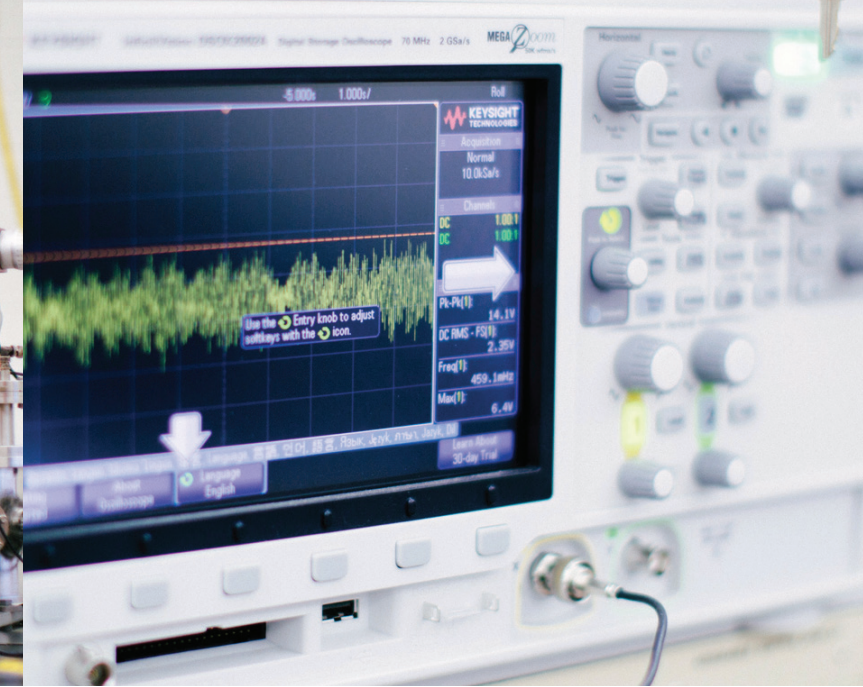
# Illinois Researchers Build Dropbox-like Storage, Analytical System for Scientific Data

As an Illinois graduate student who specializes in fabricating new semiconductor lasers, Tommy O'Brien, is like a chef, making new wafers out of his own special recipe of materials, temperature, and baking time. But unlike the technology he's designing, his method for preserving and analyzing his recipe is anything but cutting edge: he copies each recipe into a notebook by hand.

"I basically have to write down everything step by step, and it's incredibly time-consuming if I have to go back and search for information later," said O'Brien, who is pursuing his doctorate in electrical and computer engineering. "It's equally cumbersome to share information about successes or failures with my lab mates. It often doesn't happen at all."

Studies suggest that it can take up to 20 years from the discovery of new materials to the fabrication of new and next-generation devices based on these materials. The delay is due in part to the time it takes to conduct research, thanks to slow data processes, and to the loss of knowledge that occurs when vital information is tossed out or inaccessible to researchers who seek to build upon earlier work.

> "
> We have developed a cloud architecture that makes it easy for scientists to not only upload their data, but also curate and manage the data, as well as get real time search results."
>
> **KLARA NAHRSTEDT**



Researchers at the University of Illinois at Urbana-Champaign are looking to speed up the materials-to-device process through a novel framework called *4CeeD: Real-Time Data Acquisition and Analysis Framework for Material-related Cyber-Physical Environments.*

4CeeD connects microscopes and other scientific instruments to a cloud infrastructure through a high-speed University of Illinois campus network. The interface works much like Dropbox—with easy drag-and-drop uploading—but offers much more advanced data management, annotation, and analytics capabilities, along with a higher level of semantic understanding.

"We have developed a cloud architecture that makes it easy for scientists to not only upload their data, but also curate and manage the data, as well as get real-time search results," said Principal Investigator Klara Nahrstedt, the Ralph and Catherine Fisher Professor of Computer Science and CSL director. "4CeeD enables researchers to search for experiments with specific parameters and receive insights into their own work."

After researchers conduct an experiment using a scientific instrument, such as a microscope, they can upload the data, including image files, to the cloud. 4CeeD allows the researchers to tag the files with metadata, which helps researchers search for information about the experiment later.

In addition, it enables faculty members or senior graduate students to create a template that junior students can use when annotating files for similar experiments, saving time and ensuring the correct data is captured.

THIS PROJECT IS A COLLABORATION BETWEEN **Computational Science and Engineering, Computer Science, Coordinated Science Laboratory, Information Trust Institute, Materials Research Laboratory, Micro and Nano Technology Laboratory, and National Center for Supercomputing Applications.**
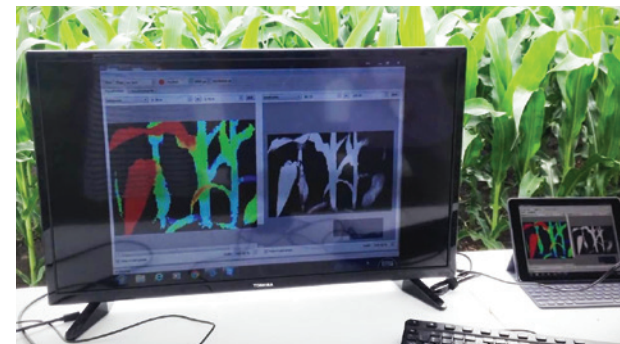
Photo by L. Brian Stauffer

*If the data are available to the breeder quickly, then they can make actionable decisions that enhance production."*

**GIRISH CHOWDHARY**

# Girish Chowdhary Leads Development of Autonomous Robot for Crop Evaluation

A semiautonomous robot may soon be roaming agricultural fields gathering and transmitting real-time data about the growth and development of crops, information that crop breeders—and eventually farmers—can use to identify the genetic traits in plants likely to produce the greatest yields.

A team of scientists based in the Carl R. Woese Institute for Genomic Biology, led by CSL Assistant Professor Girish Chowdhary, is developing the robot in partnership with researchers from Cornell University and Signetron Inc.

Inspired by the autonomous rovers used to search collapsed buildings and other dangerous environments, the agricultural robot is propelled on continuous tracks, or miniature tank treads, which enable it to navigate through dry or muddy fields. Researchers guide it using GPS and a laptop computer.

Traveling between the crop rows, the robot uses hyperspectral, high-definition and thermal cameras, weather monitors and pulsed laser scanners to capture phenotypic information—such as the stem diameter, height, and leaf area of each plant—and assess environmental conditions, such as the temperature and moisture content of the soil.

The robot stores the data in its onboard computer and transmits it in real time to the grower's computer. Scientists use the data to create a 3-D reconstruction of each plant, develop predictive models for the plant's growth and development, and estimate the biomass yield for each plant and the entire plot.

"Immediate access to the data is very important for crop breeders in the U.S.," said agricultural and biological engineering professor Girish Chowdhary. "It's very important for them to see and visualize the data. If the data are available to the breeder quickly, then they can make actionable decisions" that enhance production.

Chowdhary, whose research focus is field robotics, is modifying the robot's current design to reduce its width so it can maneuver more easily between crop rows. He also plans to install a sensor system for detecting and avoiding obstacles.

To reduce the production costs associated with the robot's current metal and track

construction, Chowdhary's team is exploring the feasibility of producing some of the components via 3-D printing.

"We are targeting a cost to the breeder of $5,000 to $10,000, which means we will have to get the manufacturing cost significantly below that," Chowdhary said. "An agricultural robot that costs just $5,000 is a totally new concept. Agricultural equipment today typically costs hundreds of thousands of dollars. Bringing the cost of our robot below $5,000 will be in itself a significant achievement for our team."

The team expects to have a prototype built within two years and begin manufacturing thereafter, with the goal of having the robot on the market by 2021.

# ILLINOIS

## CSL | Coordinated Science Lab

**COLLEGE OF ENGINEERING**

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**csl.illinois.edu**

**CYBERSECURITY & TRUSTWORTHY SYSTEMS**

**INTELLIGENT ROBOTICS**

**HEALTH CARE ENGINEERING SYSTEMS**

# CSL STUDIO
## GRAND OPENING

### PUBLIC RECEPTION
**Monday, October 2, 2017
3:00-5:00pm | CSL Studio**

1206 W. CLARK ST., URBANA

Please join us for demos of intelligent robotics, a power grid testbed, health care robots and more!

**The Studio** is the Coordinated Science Laboratory's new interdisciplinary research space focused on solving grand societal challenges.