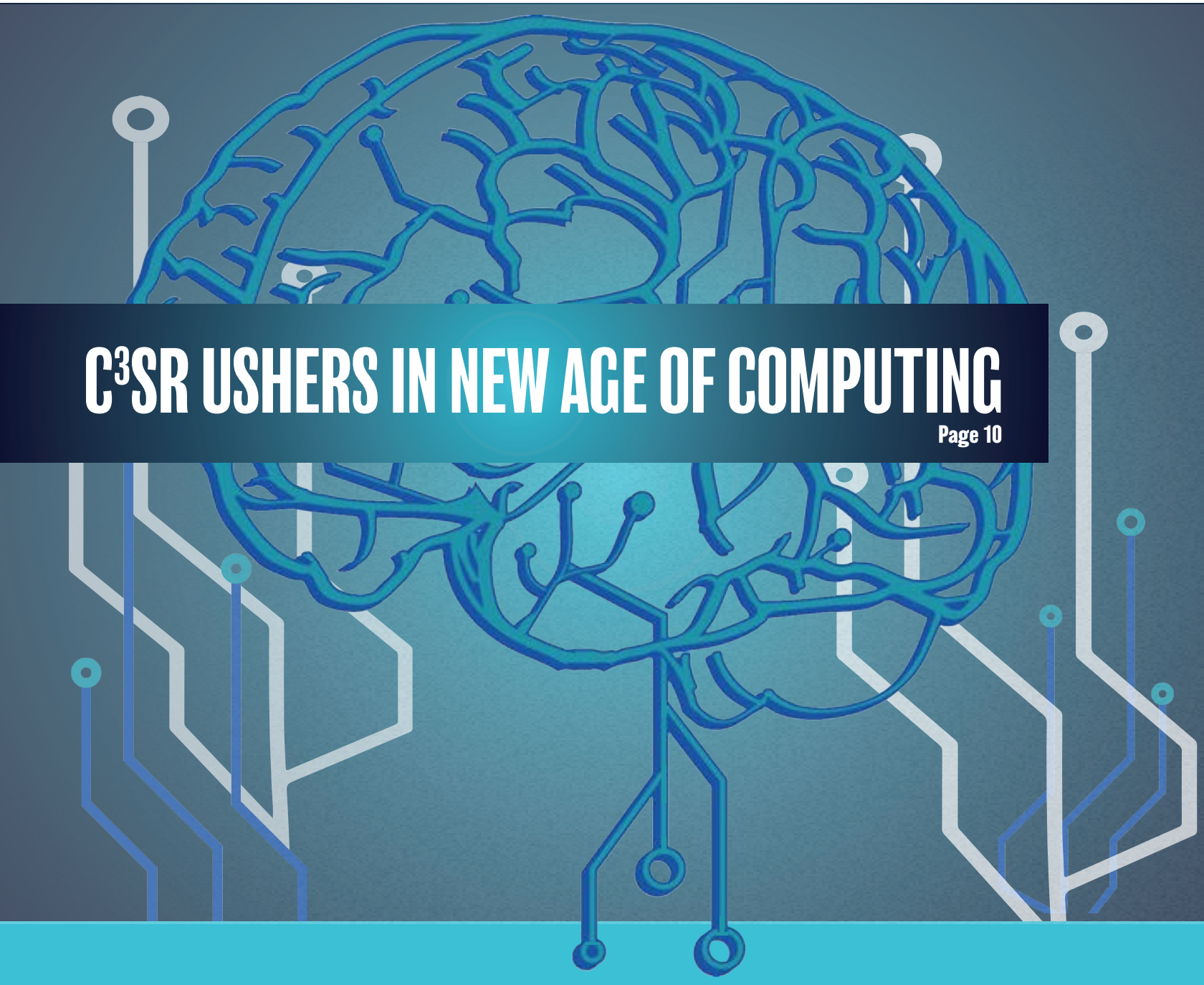
Coordinated Science Lab Newsletter
GRAINGER COLLEGE OF ENGINEERING

SPRING 2020

CONNECT



C³SR USHERS IN NEW AGE OF COMPUTING

Page 10

ILLINOIS
Coordinated Science Laboratory
GRAINGER COLLEGE OF ENGINEERING

AUTONOMOUS VEHICLE SAFETY
Page 8

$4.4M DISTRIBUTED SPACE TELESCOPE
Page 14

Contents

CONNECT
SPRING 2020

COORDINATED SCIENCE LAB
Grainger College of Engineering
University of Illinois at Urbana-Champaign

csl.illinois.edu

MANAGING EDITOR
Kim Gudeman

CONTRIBUTING WRITERS
Kim Gudeman
Allison Arp
Lizzie Roehrs
Rebecca Gorski

DESIGN
Wes Moore

Comments and suggestions are welcome!
Please send them to kgudeman@illinois.edu

Director's Message | Klara Nahrstedt

The field of computing sits on the edge of transformation. Thanks to advancements in hardware and the growing use of artificial intelligence, computing is preparing to take another leap forward, offering unprecedented computational power, energy efficiency, and intelligence.

The Coordinated Science Lab is helping to lead this transformation by contributing to new paradigms that are changing the way we think about computing. Our research is paving the way for everything from new enterprise solutions coming in the next few years to the seeds of futuristic science that may take a decade or more to be commercialized.

One highlight is the cognitive computing underway in the IBM-Illinois Center for Cognitive Computing (C^3SR), which you can read about later in this issue. Led by CSL's Wen-mei Hwu and IBM's Jinjun Xiong, C^3SR is leveraging AI/cognitive computing to rethink the design of applications, software, and hardware in order to create more intelligent systems, such as a learning platform that evolves with the needs of end users.

Many others are working on new computing paradigms as well. For example:

- Researchers such as Naresh Shanbhag, Lav Varshney, Andy Singer, and Pavan Hanumolu are designing new cognitive computing, approximate computing, and stochastic information processing systems, which are enabling energy efficiency and robustness in emerging nanoscale beyond-CMOS functional fabrics.

- R. Srikant, Radhika Mittal, and I are among the researchers who are contributing to autonomic computing, with the goal of creating self-managed, self-optimized systems.

- We have a plethora of faculty who are working on ubiquitous, pervasive computing for IoT, mobile, and wearable devices, such as Romit Roy Choudhury, Haitham Al-Hassanieh, Tarek Abdelzaher, Matt Caesar, and others.

- And finally, researchers such as Eric Chitambar, who is new to CSL, are contributing to the relatively new body of quantum computing research. Computing at the quantum scale will require new mathematical theories to enable its many promises.

This list is not exhaustive, but clearly demonstrates that CSL is a hotbed for advances in everything from low-level hardware to high-level applications. We look forward to continuing to push the boundaries.

FACULTY HIGHLIGHTS

Nahrstedt, Alleyne among eight 2019 AAAS Fellows from Illinois

CSL Director Klara Nahrstedt and Professor Andrew Alleyne were among eight Illinois professors elected to the 2019 class of the American Association for the Advancement of Science. Nahrstedt is the Ralph and Catherine Fisher Professor of Computer Science and director of CSL. She is a member of the Academy of Sciences in Germany and belongs to the Excellence Commission appointed by the Joint Science Conference of the German Federal Government. Alleyne is a Ralph and Catherine Fisher Professor in the Department of Mechanical Science and Engineering. He is a fellow of the American Society of Mechanical Engineers and IEEE in addition to serving on the U.S. Air Force Scientific Advisory Board and the National Academies Board on Army Research and Development.

Huang among eight Illinois researchers who rank among world's most influential

Eight Illinois faculty members, including CSL's Thomas Huang, have been named to the 2019 Highly Cited Researchers list, a global listing of scientists who produced the past decade's most influential papers. The list includes 6,216 researchers and honors their performance in 21 fields and cross-field influence in scholarly publications from 2008 to 2018.

Kumar receives Ten-Year Retrospective Most Influential Paper Award

Rakesh Kumar's paper "Slack Redistribution for Graceful Degradation Under Voltage Overscaling" was announced as the winner of the Ten-Year Retrospective Most Influential Paper Award at the 25th annual Asia and South Pacific Design Automation Conference. Kumar's paper showed that when you reduce the voltage of a circuit, processors can fail catastrophically, but that it's possible to reshape circuits to prevent failure. These findings significantly impacted how people thought about the interaction between reliability and hardware design, and spawned a new direction for research.

Başar awarded honorary doctorate from KTH Royal Institute of Technology

In November, CSL Professor Tamer Başar, standing center-stage in the same arena in which Nobel Prizes are given each December, was awarded an honorary doctorate by the KTH Royal Institute of Technology. The award is considered to be a rare honor for an individual outside of Sweden. This degree is the fourth honorary doctorate for Başar.

NEW FACULTY

From Illinois to Disney & back again: Introducing Joohyung Kim

It has been called the most magical place on Earth. But the secret to much of Disney's "magic" is actually state-of-the-art engineering. For the past seven years, Joohyung Kim has helped to create the science behind the robots and animatronics that entertain millions each year. At Illinois, he plans to continue work that he started at Disney: creating more human-like robots.

What can you share with us about your experiences with Disney?

My research was on how to keep all the components of the robot in the character's shape while keeping the motion as similar as possible, which involved motion control, design optimization, and also human-robot interactions. I had developed a hopping robot inspired by Tigger from Winnie the Pooh, and there was a robot named SnapBot with detachable/reconfigurable parts that was inspired by Olaf from Frozen.

You visited CSL as a research student from 2005–2007. What brought you back to Illinois?

Illinois is a really good school for engineering and I really enjoyed the time here. In 2004 I got interested in passive dynamic walking control at a time when there were few researchers working on it. One of them was Professor Mark Spong (then a professor at CSL). I joined his lab for two years and it was great.

I came back to academia because robotics is a multi-disciplinary field and I really want to collaborate with lots of people. At a university like Illinois, all the engineering fields on campus are good and connected to other universities so I can have more collaborators.

What are some things you're currently working on?

I will continue working with human figure animatronics, capturing an actor's motion and retargeting (or replicating) it to robots. I want to recreate daily life motions in the robot. It's very important to convey all the expressions of humans, because if people cannot understand what the robot or humanoid is doing, it could be dangerous.

What are your research goals?

I want to help people with robotics technology. Up until now, my goal was to make what I wanted to make or to entertain people. That's important, but now I want to do something more. In the robotics field we could use humanoids for providing labor in daily life, or helping disabled or elderly people.

Hauser brings robotic motion expertise to campus

Kris Hauser joined Illinois as associate director of robotics for the Center for Autonomy in CSL. Hauser comes directly from Duke University, and brings with him the Intelligent Motion Lab. In addition to his work at Illinois, he is also a consultant for Waymo.

What are the goals of your research and the Intelligent Motion Lab (IML)?

My general research topic is robot motion planning and control. Robots need to make decisions about how to behave in order to accomplish interesting tasks. My lab provides software for robots to make sense of the world and perform the behaviors their designers ask them to do.

What we're trying to do in IML is develop the algorithms that power robots' decisions. By that, I mean that the same algorithms can accomplish seemingly unrelated kinds of tasks. Our lab is somewhat unique in that we don't just work on software, we try to build the systems themselves to study how our algorithms work on these prototypes in real-world scenarios.

What brought you and your lab to Illinois?

I am impressed by the scale of resources and the depth of activities that are happening at Illinois. Robotics really requires having people from many disciplines working together to solve difficult problems. The robotics group has almost doubled in the last couple of years, and that comes with more research projects, more interesting classes for students, and more state-of-the-art facilities that support all these activities.

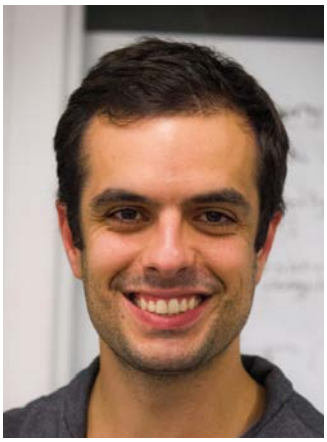
What can you share with us about your experiences with Google's Waymo?

It's amazing to see the robotics industry taking hold and getting these types of investments and resources at a scale only found in industry. To see all the activity at Google, Amazon, NVIDIA, and other companies is really thrilling.

What is something you're currently working on?

One of the things we're gung-ho on is the idea of telerobotics. We are building a system called TRINA that is a mobile manipulation robot meant to be controlled by a human operator that can perform nursing tasks in a quarantine environment. This is useful because in outbreak scenarios and for patients who are immunocompromised, nurses can perform their duties without putting themselves or the patient at greater risk of infection.

ALUMNI FEATURES



CSL alum codes the future of autonomous technology

Thiago Marinho began developing self-driving vehicles when he was an intern for CSL Professor Naira Hovakimyan. He later returned to earn his PhD, writing his thesis "Bio Inspired Vision Based Evasion Control." After graduating, Marinho (MechSE, '19) accepted a position with Waymo, a subsidiary of Google's parent company, Alphabet, Inc.

"I am proud to be part of a project at Waymo that has safety as its top priority," said Marinho. "Developing self-driving cars means working on a technology that has the potential to save hundreds of lives every day. Developing and supporting control systems is a fundamental part of making self-driving cars safe."

Marinho is currently developing a subsystem that allows self-driving vehicles to operate in a variety of scenarios, which will help improve the performance and capabilities of Waymo's self-driving technology. He credits his time at CSL with giving him the background needed for his job.

"CSL's large control group allowed me to interact with many different focuses, opening my mind to other areas of control that I would not have been exposed to through my research alone," Marinho said. "A lot of my experiences in the CSL Studio robotics lab, such as working with drones and embedded systems, is fundamental to the work I do today."

Former CSL student's research on inaudible acoustics honored with PhD Thesis Award

Former CSL student Nirupam Roy's inventions in inaudible acoustics and their wide impact on Internet of Things (IoT) research have earned him the 4th annual CSL PhD Thesis Award.

Roy's research involves using frequencies above a normal human's hearing range (20–20,000 hertz) to block or jam microphones, preventing unapproved recordings. While those frequencies are normally inaudible to microphones as well, Roy shows how the nonlinearity of the channel can be exploited to make them audible to microphones.

"Imagine we are having a conversation in a room, but we don't want this conversation to be recorded with any microphone," said Roy, currently an assistant professor in computer science at the University of Maryland, College Park. "Using an inaudible sound, we can create an inaudible jammer that can block all microphones in the room but will not interfere with the conversation."

It is clear Roy's research has had and will continue to have an impact, but that's not the only reason he received the award. His research is also interdisciplinary, a condition for the award that Roy found easy to achieve within CSL.

"CSL is a place of collaboration. I never hesitated to talk to the faculty and fellow students about my research," said Roy. "I think CSL has become an ideal place for bleeding-edge research that requires interactions of minds from different fields of science."

CSL professor works to reduce fake news dissemination

Etesami

With the United States in the midst of another election cycle, many researchers are trying to prevent the sharing of fake or bad news. CSL Assistant Professor Rasoul Etesami is working to improve the models behind social media tracking, in order to better understand how bad news is shared.

“In social networks, decision-makers are humans, and they decide who to interact with and how to manipulate others’ opinions,” said Etesami. “We want to study the stability of such networks, in terms of if an outcome can be predicted or controlled toward a certain direction.”

Most of the current models analyzing social networks act as though a network, whether social or power, is fixed and time-invariant. In these models, there is a network (for example, Facebook), there are agents (humans), and there is interaction (sharing of content), between the agents, resulting in an outcome. Etesami believes such models don't accurately portray how networks operate, because agents’ decisions and their interactions dynamically evolve, thereby changing the structure of the network.

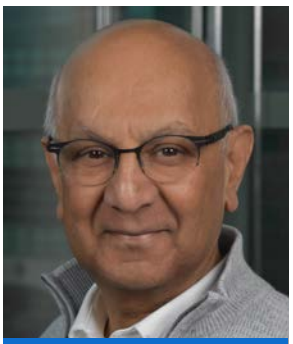
“There isn’t one well-accepted model in cognitive decision making. There are proposed models, and some of them have proved successful and more descriptive compared to others,” said Etesami, an industrial and enterprise systems engineering assistant professor. “Our project is to take those models and analyze them critically. If we see shortcomings in existing models, we extend them by adding extra features or constraints to capture more realistic and sophisticated scenarios.”

As an example, Etesami brought up the last U.S. presidential election, which some people believe was influenced by the spread of false news over social media platforms. Whether or not that's true, Etesami says such dissemination of false information is a concern.

“You can easily manipulate people’s decisions by spreading false news over a network that causes people to connect or disconnect themselves from the true source of information based on whether they like or don’t like the message,” he said. “If we have a better understanding of the dynamics of agents’ decisions and the stability of the networks, we can control the propagation of false news. This can help us protect our social networks from adversarial attacks that can affect the whole population.”

As part of the recently funded project “Duality and stability in complex state-dependent network dynamics,” Etesami and his team are working to develop a platform that can simulate human behavior within a dynamic social network like Facebook or Twitter. The data collected through these simulations will allow them to observe how the relationship between networks and agents evolves, and how the agents interact with each other through connections and sharing of information. Once they have analyzed the data, the team plans to move forward with building a richer model.

CSL researchers develop platform for scalable testing of autonomous vehicle safety



Iyer

In the race to manufacture autonomous vehicles (AVs), safety is crucial—but is sometimes overlooked, as exemplified by recent headline-making accidents. CSL researchers are using artificial intelligence (AI) and machine learning to improve the safety of autonomous technology through both software and hardware advances.

"Using AI to improve autonomous vehicles is extremely hard because of the complexity of the vehicle's electrical and mechanical components, as well as variability in external conditions," said Ravishankar K. Iyer, CSL and ECE professor and George and Ann Fisher Distinguished Professor of Engineering. "Progress is being made, but safety continues to be a significant concern."

Iyer's research group analyzed all safety reports submitted from 2014 to 2017, covering 144 AVs that drove a cumulative 1,116,605 autonomous miles. They found that for the same number of miles driven, human-driven cars were up to 4,000 times less likely than AVs to have an accident. That means that the autonomous technology failed at an alarming rate, disengaging the technology and forcing the human driver to take over.

The problem researchers and companies have when it comes to improving those numbers is that until an autonomous vehicle system has a specific issue, it's difficult to train the software to overcome it. That's why the team has developed a platform that enables companies to address safety more quickly and cost-effectively by injecting errors in the software stacks in computer simulations and collecting data on the vehicle's response to these problems.

Students who contributed to the project, from left: Saurabh Jha, James Cyriac, Shengkun Cui, and Subho Banerjee

Nahrstedt to help develop pioneering system for 360-degree video creation and delivery

Nahrstedt

Imagine watching a University of Illinois football game from the comfort of your own living room, but experiencing the game as if you were on the field with the quarterback. A form of virtual reality known as "360° videos" allows a viewer wearing a headset to do exactly that. 360° videos allow viewers to experience media content in an immersive fashion, but the ability to create and deliver 360° videos to a large audience of viewers in a personalized manner over the Internet remains an unsolved scientific problem.

A team of researchers that includes CSL Director Klara Nahrstedt, the Ralph and Catherine Fisher Professor of Computer Science, has been awarded a $1.2M grant from the National Science Foundation (NSF) to develop a revolutionary new system called mi360World. The system will create, deliver, and navigate 360° videos at scale over the Internet.

Nahrstedt has previously contributed foundational research to the fields of multimedia distributed systems, 3D tele-immersion, and novel multimedia applications.

"In addition to the obvious industrial impact of the mi360World project, it will have a major impact on students," said Nahrstedt. "We will be educating a new class of multimedia systems researchers who will be in high demand in academia and the media industry."

C³SR USHERS IN NEW AGE OF COMPUTING

The next few years of AI research will shape the future of human life—and some of the leading research is being done right here at Illinois. The Center for Cognitive Computing Systems Research (C³SR) is a joint venture between IBM and the University of Illinois at Urbana-Champaign's Coordinated Science Laboratory, and its work has been attracting international attention.

AI applications can help humans learn better, work better, and live better, but only if better methods are developed for turning massive unstructured and structured data sets into AI solutions, and for deploying those solutions efficiently and economically. C³SR was created in 2016 with the mission of innovating future heterogeneous computing systems, more productive tooling for software development, and innovative methodologies to support the large-scale deployment of a variety of game-changing AI applications.

"In the future, computing is going to be more heterogeneous (having more than one processor), and the AI solution deployment will be hybrid, with both cloud and edge computing being equally important," said Wen-mei Hwu, CSL Professor, center co-director, and AMD Jerry Sanders Chair of Electrical and Computer Engineering.

"We are researching and building the right software and hardware stacks to support that kind of computing and to make developing AI solutions for that kind of computing much more productive."

C³SR has achieved success on multiple fronts, ranging from state-of-the-art research to enrichment of Illinois students' university experiences, while its technologies are increasingly impacting the broader research community. Some of the center's efforts promise to change the landscape of AI systems research and product development over the coming years.

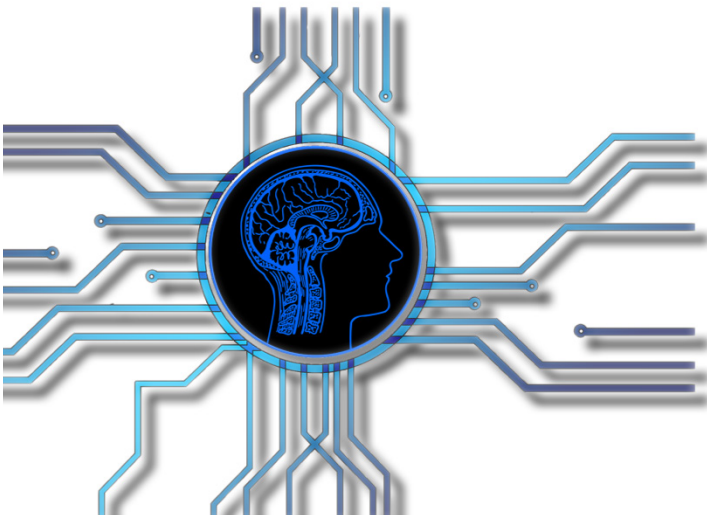
RESEARCH

The C³SR team conducts research on a continuum of hardware to software solutions, with the idea that future AI systems can best be optimized only through full-stack co-innovation. Productive software tooling research helps bridge the gap between AI solution developers and AI hardware designers, who speak different languages and optimize for different metrics. The software tooling developed by the group helps solution developers fully utilize the underlying computing infrastructure, while AI hardware research can create the right kind of computing infrastructure to support large-scale deployment of various AI solutions.

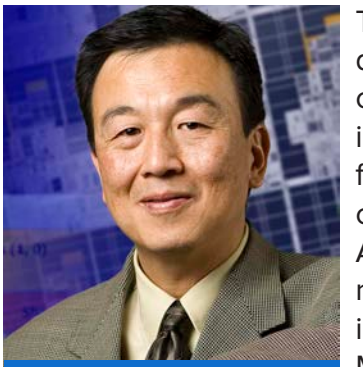
Xiong

"The research in challenging AI solutions helps us better understand the design patterns of complex AI solutions and the algorithm, computation, storage capacity, and bandwidth requirements for the underlying infrastructure," said Jinjun Xiong, center co-director and program director for IBM Cognitive Computing Systems Research at the Thomas J. Watson Research Center. "The C³SR team is currently exploring a number of different AI solutions."

One of the most challenging and futuristic AI solutions produced through the partnership, the Creative Experiential Learning Advisor (CELA), complements traditional lecture/examination-based learning by actively engaging learners in efforts to understand learners' personalized needs. Ultimately, it helps instill and reinforce understanding. The CELA work has encompassed some of the most fundamental AI science research topics, ranging from natural language understanding and video and image understanding to computational creativity.



Another AI solution from C³SR is an automated paper reviewer matching system. It helps conference program chairs and journal editors automatically identify appropriate reviewers for paper submissions while accounting for various constraints, such as conflicts of interest, workloads, and the ever-evolving research interests of reviewers.



Hwu

The C³SR team has deep understanding of the computing infrastructure needed for AI solutions, and can conduct highly focused AI hardware systems research. One project is developing Near Memory Acceleration (NMA). With NMA, data are not moved to computing processors; rather, computation is brought close to where data are located. Benefits include improved data processing speed, reduced data movement bandwidth, and high energy efficiency, which are particularly important for AI solutions that require processing of large amounts of data.

The C³SR team's work has been recognized internationally, with researchers taking home three first-place awards in the Human Parsing Challenge at the 2018 Conference on Computer Vision and Pattern Recognition; two first-place awards in the System Design Contest at the 2019 Design Automation Conference; and first place in the NVIDIA AI City Challenge, among other recent accolades. The group has published 126 papers (most at top-tier AI and systems conferences) and won three Best Paper Awards, three Best Poster Awards, and two nominations for Best Paper Awards.

EDUCATION

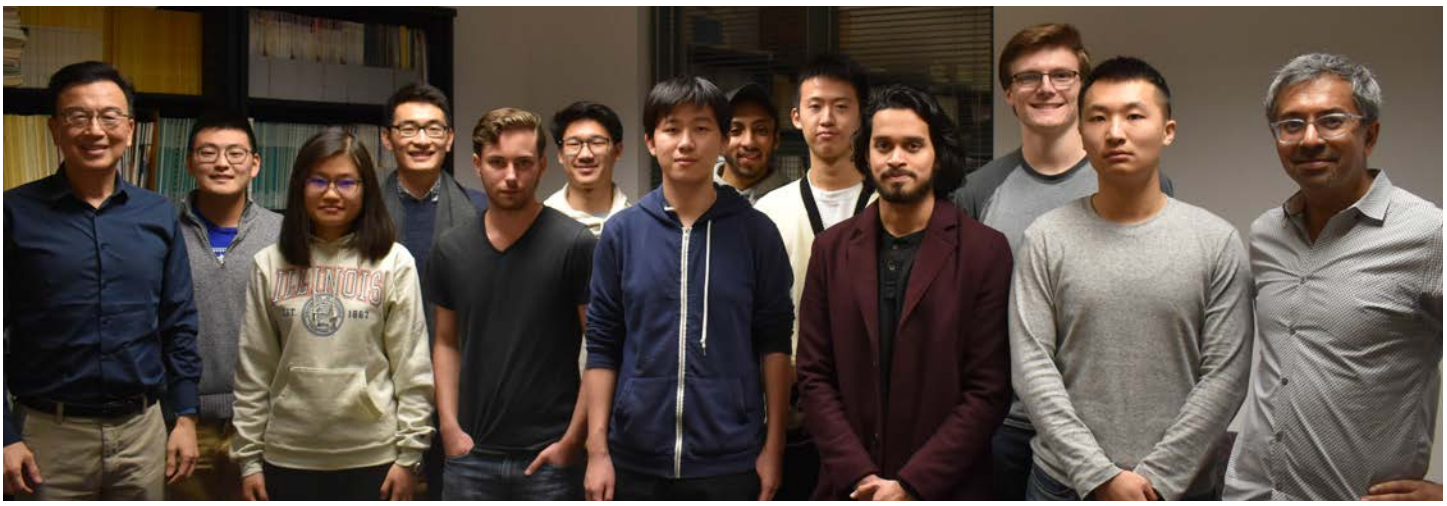
Training of Illinois students in the latest AI science and technology is a big part of the C³SR collaboration. Students not only conduct advanced AI research that addresses practical industrial needs, but also receive valuable mentoring from experienced IBM researchers on a daily basis.

C³SR's newest education effort is its partnership with the Illinois Scholars Undergraduate Research Program (ISUR). In Fall 2019, the two entities introduced the Undergraduate Research in Artificial Intelligence (URAI) program on campus. URAI allows undergraduates to work with C³SR faculty and graduate students on AI research, enabling the undergraduates to contribute to new technology, participate in AI competitions, co-author publications, and receive scholarships.

The C³SR faculty are seeking other new ways to enrich students' experiences. One recent Illinois endeavor, the tech start-up Alchemy, provides a new learning opportunity for undergraduate and Master's students who want intensive research experiences. Led by CSL/C³SR faculty member Sanjay Patel, Alchemy allows students to work together to develop research solutions to real-world problems.

The goal is for students to develop new technologies with which they can start their own companies, or that an existing company might acquire. The first cohort of Alchemy students is nearing the end of their commitment, and two projects have already attracted interest from potential buyers.

Internships at IBM offer C³SR students another way to gain experience. Since the center's inception, IBM has hired more than 20 of its students as interns. While each internship officially lasts for one summer, students' projects often continue long after their internships are over, sometimes at IBM, if a graduate gets hired. Through the internships, students gain research experience and improve their skills, while also giving IBM access to a pipeline of qualified potential employees.



The first cohort of Alchemy students with Professors Wen-mei Hwu (far left) and Sanjay Patel (far right)

BROADER TECH IMPACT

The C³SR team wants to produce results that truly matter to the world, so they have made the center's technologies accessible to everyone in the form of open-source software and systems. Thus, others can build on the center's work. It may seem surprising that IBM is funding open-source research that could help its competitors, but the company has its eye on the long-term benefits.

"The best way to help IBM in the future is when technology they developed becomes widely adopted by the industry in general," said Hwu. "Some of the developments are released as open-source to be a resource that can lift the entire industry IBM belongs in."

Of course, IBM also benefits directly from the partnership. Students become familiar with IBM's research and operations, and if they eventually join IBM, their C³SR experience reduces the amount of onboarding and training needed.

The collaboration also raises student awareness of IBM technologies. Coursework is one way that IBM technologies get put in front of students. Hwu has integrated IBM's Power Server into his ECE 408 (Applied Parallel Programming) and ECE 508 (Manycore Parallel Algorithms) courses. Working from their own laptops, students can seamlessly utilize the latest IBM server for their homework and projects. In another course, ECE 498 (Internet of Things and Cognitive Computing), CSL/C³SR professor Deming Chen, together with Hwu and Xiong, has introduced Node-RED, an IBM-contributed open-source project that helps students develop enterprise-scale IoT solutions.

"The deep collaboration between IBM and Illinois, enabled by C³SR, is unique and has far-reaching impact beyond both partners," said Xiong. "AI's future will largely depend on open collaboration and innovation."

CSL alumnus Arvind Krishna announced as next CEO of IBM

Krishna

A former CSL student, Arvind Krishna, has been elected as Chief Executive Officer of IBM, effective April 6, 2020.

Krishna came to the University of Illinois in the fall of 1985 as a graduate student and research assistant in CSL and Electrical and Computer Engineering. His outstanding technical and leadership abilities were evident during his early years at the University of Illinois.

"I was interested in working with Arvind from the time he came to Illinois," said Krishna's PhD adviser, CSL's Bruce Hajek, the Leonard C. and Mary Lou Hoeft Endowed Chair in Engineering and head of Electrical and Computer Engineering. "Students Arvind worked with placed a heavy reliance on him to provide help in solving technical problems. He consistently finished in the top one or two in his classes, beginning with his first semester, when he took digital communications from me."

Kamalabadi receives $4.4 million NSF award to develop distributed space telescope

Kamalabadi

More than 91 million miles from the Earth, the Sun poses a mystery that has long stumped scientists and seems to defy the laws of thermodynamics: why the corona, the outer layer of the Sun's atmosphere, is 1,000 times hotter than the layer beneath it.

"Unraveling the mysteries of the universe often requires uncovering things unseen with the human eye through new sensing and imaging technologies," said Farzad Kamalabadi, CSL Professor and the Kung Chie and Margaret Yeh Endowed Professor in Electrical and Computer Engineering.

Kamalabadi is the principal investigator of a $4.4 million project, newly funded by the National Science Foundation, to develop a first-of-its-kind distributed telescope that will provide unprecedented resolution for space imaging, which could lead to a new understanding of space. The project, characterized by NSF as having "a transformative technological approach," is a collaboration among 10 universities and the NASA Goddard Space Flight Center, with Illinois as the lead institution. The telescope will demonstrate a number of breakthrough technologies, including precision formation flying, novel diffractive optics (splitting of a single beam into multiple beams that can be focused at different points along the same axis), computational imaging, and 5G-inspired high-data-rate inter-satellite communication.

According to the NSF, the "CubeSat Ideas Lab: VIrtual Super-resolution Optics with Reconfigurable Swarms (VISORS)" project "will provide a transformational leap" in revealing filamentary structures in the layer of the Sun's atmosphere known as the corona – an aura of plasma that surrounds the Sun. The project aims to provide insights into the origins of coronal heating, a fundamental yet unanswered question in space science and stellar astrophysics.

Figure 1

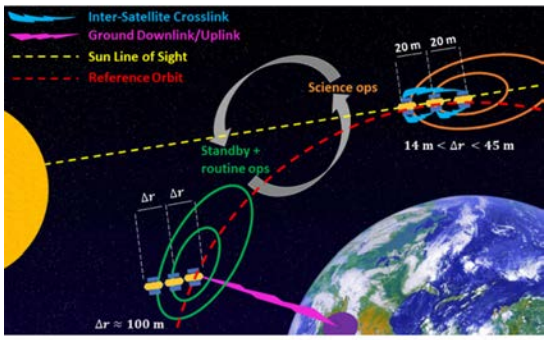
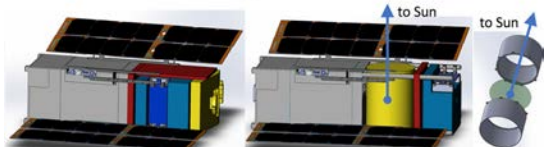


Figure 2



VISORS formation flying configuration of three small satellites in low Earth orbit implementing a distributed space telescope (Figure 1), with the leading spacecraft (Figure 2, center panel) hosting the diffractive optics (Figure 2, right panel), and with the last spacecraft in the formation hosting the imaging detector (Figure 2, left panel).

All aspects of the telescope will be handled by the VISORS team, from design to development, construction, and deployment. The resulting product will be a new class of space telescope with a resolution that is currently unavailable, allowing researchers to investigate astrophysical processes in unprecedented detail and, according to Kamalabadi, enable new scientific discoveries.

“Many scientific discoveries come about as a result of our ability, through technological breakthroughs, to observe phenomena at scales unseen before,” said Kamalabadi. “There are many such examples, including Nobel Prize-winning discoveries such as the Higgs boson observed by the Large Hadron Collider and gravitational waves detected with laser interferometry. More recently, Very Long Baseline Interferometry enabled the radio-imaging of black holes.”

Graduate and undergraduate students will participate in all stages of development, and the new technologies will be demonstrated in classrooms at partner institutions through an open-source software toolkit to be developed by the team. For younger audiences, there is a plan for a hands-on demonstration of the virtual telescope for a science museum exhibit.

“Small satellites have always had a very strong student participation component,” said Kamalabadi. “This human capacity building aspect of small satellite development was envisioned by NSF to provide opportunities to capture the imagination of students in activities that go beyond what is typical on most campuses, and to prepare the next generation with the skillsets needed to innovate in the ever-expanding arena of space technologies.”

CSL professors among 2020 Jump ARCHES grant recipients

CSL researchers are co-leading four of the 14 research projects recently announced by the Jump ARCHES research and development program. Thomas Huang (ECE) is involved with two projects, and Suma Bhat (ECE) and Kesh Kesavadas (ISE) each have one project included in the total of $1.9 million in funding. The Jump Applied Research for Community Health through Engineering and Simulation Program (Jump ARCHES) is a partnership between OSF HealthCare and the University of Illinois Grainger College of Engineering. Since its inception in 2014, the Jump ARCHES initiative has doled out more than $3.7 million for 39 projects.

SEARCCH seeks to improve cybersecurity through collaboration

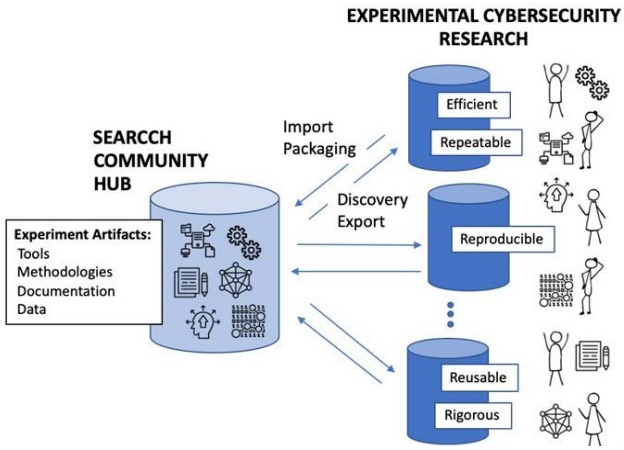
Yardley

Scientific breakthroughs are rarely made by individuals working in isolation. They require the coming together of many different minds, teams, and ideas to move science forward. To further the field of cybersecurity research, the Information Trust Institute's (ITI's) Tim Yardley, along with co-PIs from other organizations, is establishing the Sharing Expertise and Artifacts for Reuse through Cybersecurity Community Hub (SEARCCH), funded by the National Science Foundation.

Currently, the majority of cybersecurity research is ad hoc, and many experiments are irreproducible one-offs. That makes it difficult for others to confirm findings or build on them in their own work, meaning that progress in the field is slow, especially relative to the speed of new cyber developments. To improve this working model, the SEARCCH team hopes to develop an infrastructure to allow for greater communication among researchers.

"We aim to improve the overall scientific quality of cybersecurity research by enabling experiment reproducibility and needed knowledge transfer so that researchers can more easily build upon the work of others," said Yardley, principal research scientist and associate director of ITI.

The group hopes to accomplish that goal by leveraging other projects to establish a community collaboration portal that will provide an open, online "knowledge hub" to support experimentation, testing, and education for the latest cybersecurity research.



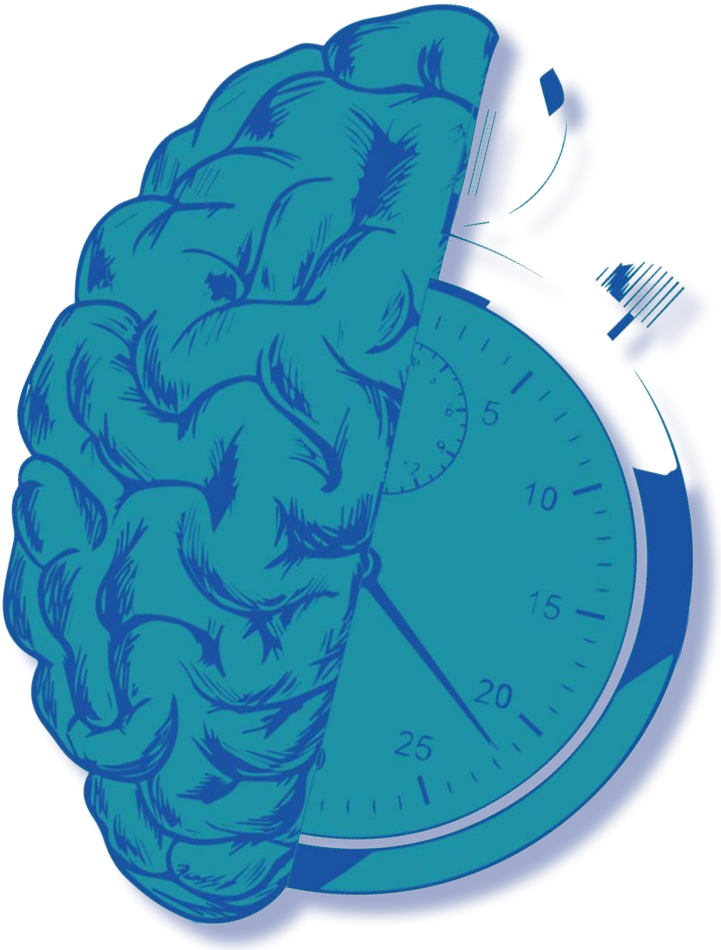
The imagined worktflow of the hub

Varshney featured in "The Age of AI," a YouTube Originals series

CSL Assistant Professor Lav Varshney is featured in a new YouTube Original series, "The Age of A.I." Varshney appears in Season 1's Episode 3, "Using A.I. to build a better human," which investigates augmentation of human abilities with A.I. and our reliance on A.I. to make decisions for us. He is also expected to appear in later episodes of the 8-part documentary.

Student-led research team explores parallels between the human brain and machines

Sevüktekin



The University of Illinois has always been a champion of supercomputing. However, there is one computer even Illinois researchers can't seem to beat: the human brain. For that reason, CSL student Noyan Sevüktekin is looking to learn from the brain instead.

His paper, "Signal processing foundations for time-based signal representations: Neurobiological parallels to engineered systems designed for energy efficiency or hardware simplicity," has been published in the IEEE Signal Processing Magazine.

In it, Sevüktekin, along with CSL faculty members Andrew Singer, Lav Varshney, and Pavan K. Hanumolu, delved deeply into an area that is not widely discussed among engineers, but that the brain has mastered: encoding of information in the timing, rather than the amplitude, of information-bearing signals.

While it is common to infer meaning from social communications based on the tempo, or timing, of the communication, traditional approaches to engineered communication systems have used signal levels, or amplitudes, to convey information.

Exploring how the brain, a small, yet highly energy efficient and computationally adept data processor, functions can prove to be a valuable new pattern of thought in engineering, and is already starting to appear in a variety of smaller electronic devices, such as those found in health care and the Internet of Things.

Stephens

Student improves bioinformatics software to better analyze human DNA

CSL graduate student Zachary Stephens is changing the way medical experts examine and analyze the vast amount of DNA in the human body, ultimately contributing to the drive toward individualized medicine.

Stephens splits his time between the University of Illinois at Urbana-Champaign and Rochester, Minn., where he is a research affiliate at the Mayo Clinic working in clinical bioinformatics, a field that connects computing, biology, and medicine. Stephens is applying the skills he learned in the research group of his adviser, Ravishankar K. Iyer, who, along with Dr. Liewei Wang of Mayo Clinic, is leading a collaborative research initiative of Illinois and Mayo in computational genomics.

The initiative is known as the Center for Computational Biotechnology and Genomic Medicine, or CCBGM. Its goal is to use bioinformatics to allow medical professionals to dig deeper into the human genetic code by combining analytics software with modern medical science. In Stephens' area, this work involves scouring human DNA and RNA to find mutations, or "variants," that may be the underlying causes of various diseases.

While the field of bioinformatics provides an elaborate arsenal of methods to use for each step in the process of developing an actionable outcome – such as a diagnosis – Stephens says the current software is good at what it does, but isn't entirely comprehensive.

"There are certain things that aren't addressed as sensitively as they could be," says Stephens. "That's why I developed algorithms to bridge the gaps that are left by existing technology."

"I developed algorithms to bridge the gaps that are left by existing technology."

– Zachary Stephens

ITI receives an additional $4M from NSF for cybersecurity scholarships

Bashir

Modern life depends on the stability and security of computers and networks, yet there are nowhere near enough qualified cybersecurity professionals to meet the nation's needs — and ITI is doing its part to help. For a decade, the Illinois Cyber Security Scholars Program (ICSSP) has been offering scholarships to undergraduate and graduate students at Illinois in exchange for government service after graduation.

The scholarships provide full tuition plus a generous stipend, enabling talented students to pursue cybersecurity studies without worrying about financial pressures. The scholarships are being offered from the National Science Foundation's nationwide Scholarship for Service program. Under the program's terms, once students have graduated, they must work for the government for as many years as they received funding support.

"One of the reasons the government is offering this program is to build a workforce that protects information infrastructure and is sensitive to aspects of information systems that are critical to society," said principal investigator Masooda Bashir, an associate professor in information sciences, CSL, and ITI.

More than 60 students have successfully completed the ICSSP program to date, supported by more than $10 million in NSF funding. Because of the strong success of previous ICSSP graduates, NSF has renewed the program repeatedly. Thanks to the most recent funding extension of $4M, the scholarships will be offered for at least four more years.

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