INFRASTRUCTURE CENTER

continued from front page

infrastructure for education, the economy, health and community participation. In addition, the Center will work to help identify the next generation of broadband Internet applications enabled by fiber infrastructure.

Finally, the Center is working to understand and clarify the interactions between users and their infrastructures by focusing on advanced forms of visualization and the representation of complexity. To teach tomorrow's students, citizens, and policymakers about these elaborate networks, researchers will develop new educational techniques like interactive mapping and educational games.

The center's leadership hails from across the campus; the Co-Directors will be Sandvig (Media), Kevin Hamilton (Art & Design), Sally Jackson (Communication), Karrie Karahalios (Computer Science) and Cedric Langbort (Aerospace Engineering). In addition, center research involves student and faculty collaborators from New Media, Human and Community Development, Computer Science, Communications, Library and Information Science, Electrical and Computer Engineering and Sociology, among other areas.

"Infrastructures are about computers, wires and pipes but they are also about human relationships, economics and justice," said Co-Director Karrie Karahalios, associate professor of computer science. "We want to see infrastructures that not only work, but that help humans to flourish."

For more information, visit csl.illinois.edu/infra-center.

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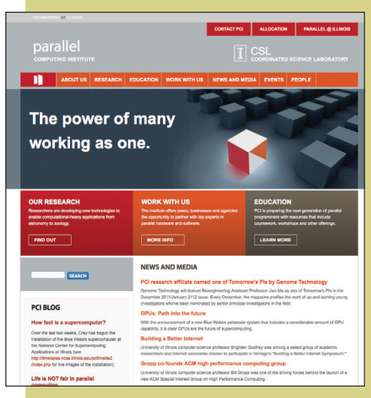

parallel.illinois.edu

The Parallel Computing Institute has launched its new virtual home at http://parallel.illinois.edu. There, you'll find information about many of the parallel activities underway at the University of Illinois.

And don't miss the PCI blog (http://parallel.illinois.edu/news-and-media/blog), which covers hot topics in parallelism and supercomputing.

Part of the Coordinated Science Laboratory, the Parallel Computing Institute has members that hail from bioengineering, computer science, electrical and computer engineering and many other fields.

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ENGINEERING AT ILLINOIS

CONNECT

NEWSLETTER OF THE COORDINATED SCIENCE LABORATORY VOL. FOUR, NO. 1 | 2012

NEW CSL CENTER TO DEVELOP "SMART" INFRASTRUCTURES

From smart utilities like the smart grid and intelligent transportation systems to social networks on sites like Facebook and YouTube, the infrastructures of tomorrow will heavily utilize information technology. While these "smart" infrastructures promise many benefits, they often require new kinds of interaction between people and the machines meant to serve them. Yet the social, cultural, economic and political side of these relationships often receives little attention.

The new Center for People and Infrastructures at the University of Illinois at Urbana-Champaign seeks to address these issues by better understanding social norms, market structures, public policies and human capabilities that shape and are affected by the development of smart infrastructures. The center, part of the Coordinated Science Laboratory, brings together experts in engineering, design, the social sciences, and computer science.

"The U.S. is in an infrastructure crisis driven by chronic underinvestment," said Co-Director Christian Sandvig, an associate professor of media. "Now we hope to modernize these foundational systems that affect everyone, but to succeed we can't think about technology alone."

For example, broadband Internet is absent, difficult to obtain and/or expensive in much of the U.S., not because the technology doesn't exist, but because of economic and public policy factors that affect the development of Internet infrastructure. In addition, smart meters for the power grid have been controversial among consumers who are skeptical that utilities are acting in their best interest.

The Center will initially focus on research about broadband telecommunications and energy. Researchers will work with fiber networks like UC2B (Urbana-Champaign Big Broadband), which will deliver high-quality broadband connections to several thousand households in Champaign and Urbana, to understand the consequences of fiber

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EAGER: IMPROVING SEARCH PROCESSES IN MULTIMEDIA

In August, the National Science Foundation (NSF) awarded the University of Illinois at Urbana-Champaign, as well as the City University of New York, a one-year, $199,360 EAGER grant.

According to the NSF website, the goal of this project, titled, "Exploring Multimedia Information Networks," is "to provide effective methods for organizing, searching, mining and reasoning with web-scale multimedia."

Today, because of the ever-expanding amount of various kinds of information on the web, traditional multimedia search processes are facing challenges.

Through this project, researchers aim to overcome these challenges by creating a structured multimedia database, called Multimedia Information Networks (MINets), which will be able to link multimedia data by identifying semantic concepts in images, video and text.

However, "trying to derive semantic concepts from these is the most difficult part," said Thomas Huang, who is the principle investigator on the project and a professor at the Coordinated Science Laboratory. He is also a professor of electrical and computer engineering and a research affiliate in Beckman Institute.

"This is not a regular grant, it is an exploratory grant," Huang said. This means that the project may or may not be successful, but the point of the research is simply to explore. "So there's high risk, but potentially high return," Huang said.

It is impossible to collect images by taking photos on your own and labeling them if you want billions of images for a database, Huang said. So in order to create this multimedia database, the researchers must crawl the web for already existing images, video and text.

Huang said that the researchers start by building a small database, such as a vehicle database that includes land, marine and air vehicles. Researchers collect multimedia data, such as photos of cars, for their database by crawling the web and can then use those photos to recognize other multimedia that wasn't previously in their database.

One of the domains that researchers are currently looking at is natural disasters, Huang said. In order to create a database about natural disasters, they must first look at the key concepts of natural disasters. However, if they are creating a database of a disaster while it is currently taking place, then they have to constantly update the database.

"This kind of concept could be really useful if it succeeds, but it's exploratory," Huang said.

In addition to MINets being able to recognize semantic concepts in order to build its database, it is also expected to work properly in the presence of noise or uncertainty. Researchers will assess Quality of Information factors in MINets such as coherence, accuracy, recall, and freshness of information.

There are four main students who are working with Huang at the University on this project: Guo-Jun Qi, Min-Hsuan Tsai, Shen Fu Tsai and Shiyu Chang. All four are graduate students in electrical and computer engineering and their primary research area is in signal processing.

While Huang and his students use their background in signal processing, he said, they collaborate with Heng Ji, the co-PI and an assistant professor at CUNY whose research interests focus on natural language processing.

"The most exciting thing is that it's a fuzzy field … there's many different directions you can explore," Huang said. "You can invent new paradigms of doing things, like new ways of doing searches for multimedia data for example."

Beckman introduces Huang Gift Fund

Beckman Institute honored CSL researcher Thomas Huang by creating the Thomas and Margaret Huang Fund for Graduate Research.

Initiatied by Huang's former students, the fund will support graduate student research in human-computer intelligent interaction, which has been the focus of Huang's research during his 22 years with Beckman.

In particular, Huang has made seminal contribution to fields such as image formation and signal processing.

From the Director

In 2011, CSL marked its 60th anniversary, celebrating the growth of a small lab into a thriving organization with three affiliated institutes, more than 150 professors from about 20 different academic departments, 51 technical and administrative staff members, and nearly 400 graduate and undergraduate student researchers. In 2012, CSL will turn its focus on building for the future – literally.

Over the past seven years, research activity in CSL and its affiliated institutes (the Advanced Digital Sciences Center, the Information Trust Institute and the Parallel Computing Institute) has grown dramatically, with annual research expenditures increasing by more than $10 million. However, it's become increasingly difficult to continue expanding our programs, as there's little physical space for growth.

That's why I'm pleased to announce CSL's first expansion project since our current building was constructed in 1993. Enabled by an investment from the College of Engineering, CSL will expand into new space in the North Parking Garage, located at the corner of Mathews Avenue and Clark Street.

There is currently 17,500-square-feet of office space on the south side of the garage; of that, the majority has been designated for CSL. The real estate will provide collaborative space for CSL's multidisciplinary research. In addition to offices, the auxiliary space may host labs, test beds, conference rooms and other work areas.

Renovations will begin later this year, with a tentative move-in date before the fall semester begins in 2013. The new space will add to the 116,600-square-feet that CSL currently occupies in the building at 1308 W. Main Street. In addition, CSL has several labs and offices in the Engineering Sciences Building at 1101 W. Springfield Ave., Urbana.

While we are excited to expand CSL's physical space, we're even more excited by the expansion of our research programs that have made this renovation project necessary. I'm more convinced than ever that CSL is looking at the right problems with the right combination of fundamental and interdisciplinary excellence.

As always, we thank you for your support as an alum, friend or collaborator. We look forward to building for the next 60 years together.

William H. Sanders

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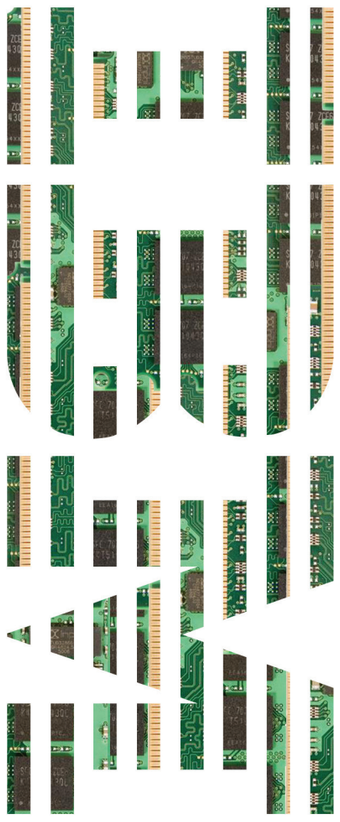
Contributing Writers: Jenny Applequist, CSL/ITI; Elise King, CSL; and Tom Moone, Electrical & Computer Engineering.

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

From CSL to IBM, Hunter finds collaboration is key to success

By April Dahlquist

Hillery Hunter is a manager and systems research memory strategist at IBM whose research background includes everything from memory power to computer architecture to silicon technologies. And her interdisciplinary interests in technology first took root at the Coordinated Science Laboratory.



As an undergraduate at Illinois, Hunter joined CSL to complete her senior research thesis in electrical engineering. Impressed by CSL's rich opportunities for collaboration, she decided to remain in CSL to pursue her Ph.D., eventually earning both a master's and, in 2004, a Ph.D. in electrical engineering.

Working primarily in Professor Wen-mei Hwu's IMPACT research group, Hunter developed several research projects related to the technology we see in smartphones and tablets today. "We were really looking at optimizing the software that runs on today's smartphones, such as multimedia and voice applications," she recalls.

"Since then, everything has been very interdisciplinary, and that's something that definitely started at CSL," Hunter says about her career. She has worked at IBM—where she held internships during graduate school—since she finished her Ph.D.

Her first work at IBM involved designing products such as Embedded DRAM—a cache technology that is a crucial component of POWER7 and z196 processors—and the next-generation System z mainframe memory hierarchy. More recently, she has been working on development of new memory technologies.

"I have worked primarily on high-end commercial systems and processors," Hunter says, noting that her main focus at IBM is on transferring technology from the research stage to the development stage. "It's very rewarding to be the bridge and the glue and the translator."

She says that her most rewarding project may have been a memory power project that led to improvements across the IBM System p and System z families. From 2008 to 2011, she was the end-to-end memory power lead for DDR3 systems, and her work resulted in millions of dollars in development expense savings and even more in systems revenues.

"I was able to stay in the project long enough to see the product through to shipping," she says.

Hunter recalls that her favorite thing about working at CSL was its strong interdisciplinary character. She was able to collaborate not only with students within the IMPACT group who had different skills and educational backgrounds, but also with researchers from other groups in CSL. She reflects, "I think that was really the power of CSL – the ability to collaborate."

Researchers receive $2.5 million to improve networked systems

By Kim Gudeman

From taking soil moisture measurements around the country to using sensing for surveillance, many modern technologies rely on networked systems.

But too often, these systems are not as efficient or reliable as they could be. That is largely because networked systems are informationally decentralized, comprise many nodes carrying disparate information and are subject to constraints on energy, data storage and computational capabilities.

CSL researchers, along with investigators at the University of Michigan, aim to address this problem by developing a general theoretic framework and tools to help optimize these sensing systems. They received a five-year, $2.5 million grant, titled "CIF: Large: Collaborative Research: Controlled Sensing, and Distributed Signal Processing and Decision Making in Networked Systems," funded by NSF.

"People are building these sensing systems with a large number of nodes, but without a theory to optimize them," said CSL professor Venu Veeravalli, Illinois' principal investigator and ECE professor. "The sensors have to communicate, coordinate and operate in a limited resource environment, which means they have to be efficient."

Researchers will study the role of information in sensing, signal processing and decision making for networked systems under various architectures, in both controlled and distributed sensing. They will also work to understand the coordination of networked systems and develop novel algorithms to enhance the functioning of these systems. In addition to three investigators at Michigan, the team also includes CSL professors Tamer Başar, professor of electrical and computer engineering, and Angelia Nedich, assistant professor of industrial & enterprise systems engineering.

To maximize efficiency, researchers will develop new event-driven sensing techniques. Today's sensors turn on and off arbitrarily to conserve energy. They may be on just 10 percent of the time, meaning they could miss significant events. The investigators aim to develop a "smart" system that functions as though it were on 100 percent of the time, even if it is in wake mode for only a fraction of that time.

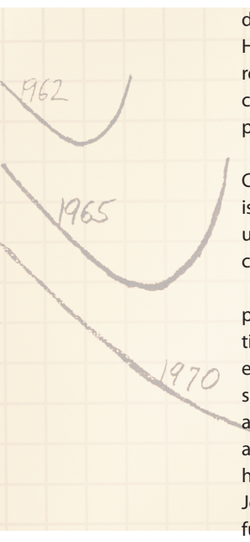
"Sensors would activate themselves only if there's information that's worth collecting and transmitting," Başar said.

Data storage is also an important component of the project. Sensors cannot store a significant amount of data, so they either eliminate it or transmit it. Researchers will develop intelligent storage, which helps identify what should be discarded and what should be transmitted.

The team will evaluate their findings using a soil-moisture monitoring test bed at Michigan. In addition, the research could apply to fire and rescue operations and any number of atmospheric and environmental operations, from the early detection of earthquakes to climate change to monitoring the impact of oil spills on oceanic life.

Veeravalli said: "As we rely more on these technologies to further our understanding of the natural world and other systems, we need to use sensors in the most effective and efficient way."

CSL grad student John Sartori outwits Moore's Law



For decades, Moore's Law has held true, with the number of transistors on a given area of a computer chip doubling every 18 to 24 months. However, as devices shrink in size, researchers are scrambling to continue advancing semiconductor performance.

With his advisor Rakesh Kumar, CSL graduate student John Sartori is addressing this problem with a unique methodology: designing chips that can tolerate errors.

"John has proposed stochastic processors that are designed and optimized to perform acceptable and energy-efficient computations in spite of hardware errors," said Kumar, an assistant professor of electrical and computer engineering. "With his work on stochastic computing, John hopes to lay out a path into the future that allows us to continue to reap the benefits of Moore's Law."

In the past, processors have been designed to work correctly because there was no fail-safe way to compensate for errors.

"People have never designed processors like this before," said Sartori of his research.

Sartori's methodology is more complex than simply permitting chips to make errors. With that approach, there would be so many errors that it would fail catastrophically. Instead, his research looks at effectively trading off reliability for energy; the key is to find a way to design processors that make errors, but in a way that the errors can be tolerated.

The research is increasingly important in an era where devices are shrinking at a faster rate than chips.

"We're getting to a point… where these transistors are getting so small that it's hard to get them to behave in the same way," Sartori said. "It's hard to make them reliable at that small of a scale."

To ensure no errors, a chip has to work at the frequency of the slowest transistor, which puts a big constraint on the hardware by using a lot of power.

"I have power and performance overheads to make sure everything on my chip works," Sartori said, noting that an increase in transistor variability has led to bigger overheads. "These overheads are so conservative that the Moore's Law scaling is going to vanish."

Sartori recently won the Best Paper Award at the 2011 International Conference on Compilers, Architectures and Synthesis of Embedded Systems (CASES) for his paper on this research. The paper was titled "Architecting Processors to Allow Voltage/Reliability Tradeoffs."

Kumar, part of CSL's Reliable and High Performance Computing Group, co-authored the paper.

NSA establishes $1 million Science of Security Lablet at Illinois

Many aspects of life have become closely intertwined with computer networks. Unfortunately, the interdependence is a double-edged sword: The electronic medical records that make it easy for a remote expert to review your test results may also make it easy for your hospital to accidentally release part of your private medical history to a publicly accessible computer.

To tackle the challenge of securing critical systems, the U.S. National Security Agency (NSA) is giving an initial $1 million to the Information Trust Institute to seed an academic "Lablet" focused on the development of a Science of Security (SoS). A major goal is the creation of a unified body of knowledge that can serve as the basis of a trust engineering discipline, curriculum and rigorous design methodologies. Such a body of knowledge would ultimately make it easier to design systems that guarantee that your medical records remain confidential and your power stays on.

David M. Nicol, the Illinois Lablet's principal investigator, explains, "The complexity of software systems guarantees that there will almost always be errors that can be exploited by attackers. We have a critical need for foundational design principles that anticipate penetrations, contain them and limit their effects, even if the penetration isn't detected."

The Illinois Lablet will contribute broadly to the development of security science while leveraging Illinois expertise in resiliency, which in this context means a system's demonstrable ability to maintain security properties even during ongoing cyber attacks.

Nicol is a professor of electrical and computer engineering (ECE) at Illinois and the director of the Information Trust Institute (ITI). The Lablet's leadership is shared with co-principal investigators William H. Sanders, who is an ECE professor and director of the Coordinated Science Laboratory at Illinois, and José Meseguer, a professor of computer science.

Başar elected to the IFAC Council

By Tom Moone, ECE

Recently, CSL Professor Tamer Başar was elected to the IFAC Council. IFAC, the International Federation of Automatic Control, is the leading international body in the field of automatic control.

Başar, a Swanlund Chair holder and professor of electrical and computer engineering, was elected to the council for a three-year term, and is representing the United States. As Başar explained, "Election to the council is based on scientific merit as well as visibility within IFAC."

Liberzon gets $300K to study robust nonlinear observers

By Elise King, CSL

The National Research Foundation of Korea recently awarded Daniel Liberzon, a researcher at the Coordinated Science Laboratory, and Hyungbo Shim from Seoul National University a three-year, approximately $300,000 grant to research and develop robust nonlinear observers.

Liberzon and Shim aim to make nonlinear observers robust to measurement disturbances. The research might apply, for example, to images taken by an eight megapixel camera. If the picture is not perfectly clear, all of the information may not be completely precise. A robust observer would be able to accurately reconstruct hidden variables even if it was given incorrect measurements.

Liberzon's contributions will be in quantized control. A quantizer device is something that converts information from analog to digital, such as a camera. Errors can occur during this process, which is why control is important.

Grad students win TECHCON awards

Elise King, CSL

In September, two CSL graduate students, Joseph Sloan and Rami Abdallah, won Best in Session Awards at the Semiconductor Research Corporations' (SRC) 2011 Technology Conference, also known as TECHCON.

Sloan presented a paper on the topic of multicore design titled, "Algorithmic Techniques for Fault Detection for Sparse Linear Algebra." His paper focuses on the problem of hardware reliability, which is becoming increasingly difficult to achieve with process scaling as technologies continue to downsize. Sloan tackles this problem in his paper by looking at how to eliminate system design margins and make the software itself robust to errors.

Abdallah presented a paper on the topic of integrated system design. His paper, titled, "Soft Computing Systems via Hardware Error Likelihood Processing," focused on identifying circuit error statistics and then trying to use various techniques to correct those errors, he said.

Godfrey to build better internet

By Jennifer La Montagne, Computer Sciecne

PCI affiliate Brighten Godfrey (CS) was among a select group of academic researchers and Internet visionaries chosen to participate in Verisign's "Building a Better Internet Symposium." Godfrey's project was one of four chosen internationally to receive a $75,000 infrastructure grant that Verisign awarded as part of its 25 Years of .Com commemorations. The forum, held in November in Washington, DC, explored how the Internet's core infrastructure can evolve to support the challenges of billions of new users, increasing complexity, and internationalization.

COORDINATED 60 YEARS OF SCIENCE 1951-2011 LABORATORY ENGINEERING AT ILLINOIS

CSL 60th symposium draws more than 200 attendees

CSL culminated a year of 60th anniversary activities with the symposium, "Building Interdisciplinary Excellence with Societal Impact," on October 28, 2011. The committee was pleased to welcome back more than 200 alums, former faculty members and friends, many of whom participated in three panels commemorating CSL's past while planning for the future.

"It was a real pleasure to celebrate CSL's milestone anniversary with a group so intimately involved with establishing our foundation," said CSL Director William H. Sanders. "I left the symposium inspired to continue thinking of ways that we could build upon the work of our predecessors."

Current faculty shared their reflections, as well, through a commemorative video. Watch it at http://www.csl.illinois.edu/video/csl-60th-anniversary.

CSL WELCOMES NEW PROFESSORS

CSL is pleased to welcome three new professors this semester:

Angelia Nedich is an assistant professor of industrial & enterprise systems engineering. Nedich's research interests are convex and nonconvex optimization; linear and nonlinear optimization; large-scale decision systems; parallel and distributed algorithms; variational inequalities; and opinion dynamics. She holds a Ph.D. in electrical engineering from MIT.

Also an MIT grad, **Alejandro Dominguez-Garcia** is an assistant professor of electrical and computer engineering. His research interests lie at the interface of system reliability theory and control, with special emphasis on applications to electrical energy systems that include: coordination and control of distributed energy resources; integration of renewable resources in power systems; reliability modeling of electrical energy systems and components; and health monitoring and fault diagnosis in electrical energy systems.

Maxim Raginsky is a member of the ECE faculty. He is interested in theoretical and practical aspects of information processing and decision-making in uncertain environments under resource and complexity constraints - -drawing on the fields of information theory, statistics, game theory, optimal control, and signal processing. His Ph.D. in electrical engineering is from Northwestern University.