KU

Information and Telecommunication Technology Center

ANNUAL REPORT 2010-11

ITTC conducts advanced research, provides hands-on educational opportunities for students, and provides technological assistance and new technologies—all with the aim of building a more diverse, robust Kansas economy.

Research
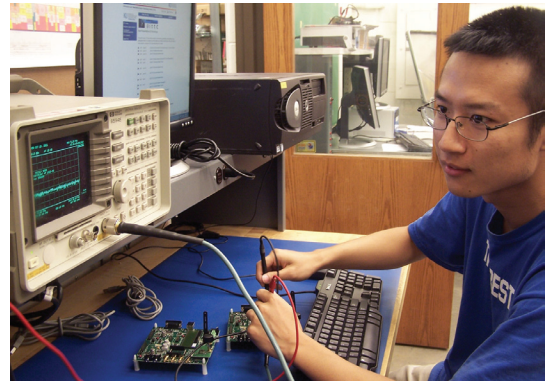
Education
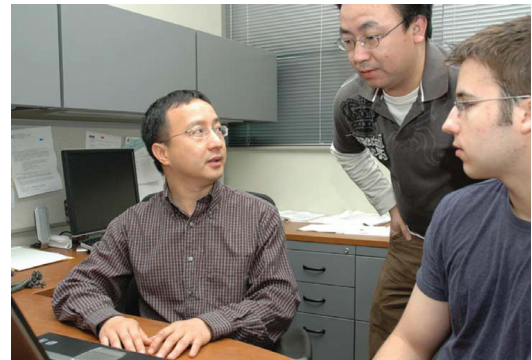
Technology Commercialization

News From
Perry Alexander, ITTC Director

I t is an exciting and noisy time at ITTC! The expansion of the Bioinformatics Computing Facility (BCF) has begun. Additional KU researchers and businesses will have access to the state-of-the-art high performance computing facility when it is completed in the spring of 2012. The BCF is a great example of how we can efficiently and effectively use University-wide talent and resources to expand opportunities.

Exploring new avenues of collaboration is a hallmark of ITTC. In fact, this marks the 10th anniversary of the e-Learning Design Lab, which brings together researchers from across KU to develop new technologies for online learning and teaching. Thousands of Kansas children are receiving extra help in math through online tutorials developed by e-Learning researchers. It is one of the many successes during its first decade in existence.

ITTC researchers are receiving high praise for their innovative endeavors. In recognition of our accomplished history and continued excellence in radar research, ITTC was selected to host the prestigious IEEE Radar Conference in May. ITTC investigator **Daniel Deavours** was invited to the Massachusetts Institute of Technology (MIT) to teach and collaborate on radio frequency identification (RFID) technologies. He has pioneered technology that greatly improves the performance of the next-generation bar code. **Xue-wen Chen**, director of ITTC's Bioinformatics and Computational Life-Sciences Lab, was selected as the co-Chair for the first IEEE Conference on Healthcare Informatics, Imaging, and Systems Biology. Most recently, Dr. Chen received a $1.5 million NSF grant to develop a searchable online database to assist in climate change, evolutionary, and other biodiversity research.

The Center is a fertile training ground for the technology leaders of tomorrow. Our students gain hands-on experience, conducting experiments and analyzing data on complex problems. This spring ITTC doctoral students **Andrew Farmer** and **Evan Austin** received national honors for their research efforts in computer systems.

Our Office of Technology Commercialization works with Kansas businesses and entrepreneurs to move technologies from the lab to the private sector. Listening to the needs of Kansans, ITTC has created the Mobile Apps Project that will provide affordable, reliable, and creative apps that can increase productivity and expand the customer base. The innovative technologies developed at ITTC can foster economic growth and create IT jobs in the state.

We look forward to working with new Associate Vice Chancellor for Innovation and Entrepreneurship Julie Goonewardene and her staff to accelerate our commercialization efforts.
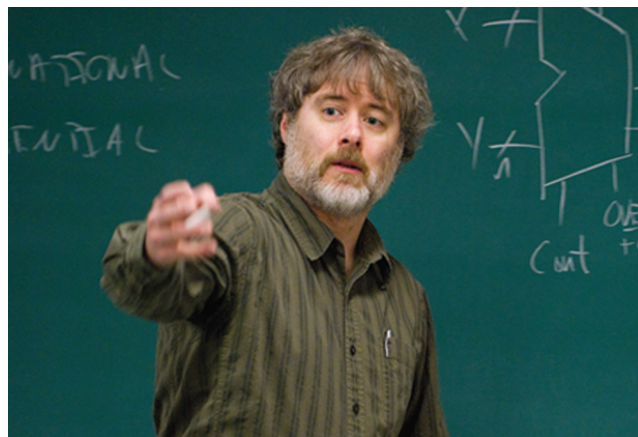
ITTC Director Perry Alexander exemplifies the ITTC mission of research, education, and technology commercialization. He is an acclaimed researcher who helped KU earn a National Center of Academic Excellence in Information Assurance Education designation in 2009. This May Dr. Alexander received a John E. Sharp and Winifred E. Sharp Teaching Professorship from the School of Engineering and the Harry Talley Excellence in Teaching Award. This is the third time Dr. Alexander has won the Talley Award, which is voted on by graduating EECS seniors. He also founded Cadstone, the start-up company that has become the leading provider of language-based system-level design tools and services.

ITTC Leaders Build Community of Researchers

ITTC Associate Director **James Stiles** knows ITTC can't compete with the coziness of coffee shops, the convenience of home, or the myriad of other places where students can work from their laptops. But he believes ITTC offers students something much richer than a caramel macchiato—a community of talented, innovative researchers from multiple disciplines.

Dr. Stiles and ITTC Director **Perry Alexander** are working to strengthen the ITTC community by providing regular opportunities for faculty, students, and staff to interact, and by publicly recognizing and supporting researchers' hard work.

Too often looming deadlines and long to-do lists leave researchers feeling they do not have time to chat with colleagues. But innovation is a group activity, as ideas are made stronger by multiple viewpoints.

Before these collaborations can occur, relationships need to be built. ITTC hosted an ice cream social to welcome new and returning students in August. After making sundaes, ITTC students, faculty, and staff chatted in the atrium of Nichols Hall.

Two student teams were recognized for their outstanding research during the Center-wide meeting that followed the ice cream social. Industry Advisory Board (IAB) members voted on the best student poster during their annual meeting in June. While the student poster session has long been a part of the IAB meeting, the competition served as a way to reward the hard work of ITTC students with gift certificates for members of each winning team. Out of more than 60 student posters, two groups tied for first place:
     Daniel Fokum, **Martin Kuehnhausen**, **Matthew Zeets**, and **Angela Oguna**; "Experiences from a Transportation Security Sensor Network Field Trial" and
     Abdul Jabbar, **Justin Rohrer**, and **Egemen Çetinkaya**; "Weather Disruption-Tolerant Networking for Millimeter-Wave Metropolitan Mesh Networks."

In March, ITTC investigator **Jun** "**Luke**" **Huan** gave an overview of the Bioinformatics and Computational Life-Sciences Lab (BCLSL) in a "What do they do?" presentation. Members from each ITTC lab have or will give an overview presentation of their research to increase understanding and opportunities for collaboration. ∎

Top Picture: ITTC students and faculty members take part in the ice cream social in August.
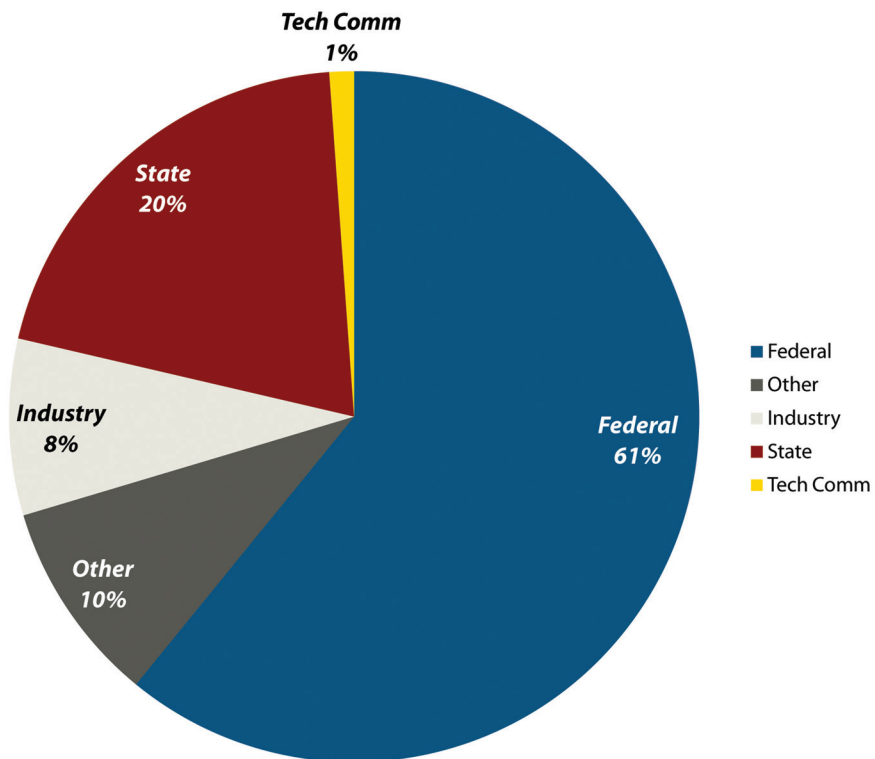
ITTC Associate Director James Stiles, right, awards prizes to the winners of the ITTC Advisory Board poster competition. ITTC doctoral student Daniel Fokum, left, accepted the monetary award for his group.

Graduate student Ashwini Shikaripur Nadig, right, describes her research to doctoral student Jong Cheol Jeong during a "What do they do?" presentation.

ITTC By the Numbers

Total Expenditures from External Sources $3,576,779

Total Revenue from External Sources $3,719,167

Active ITTC-Affiliate Tenure Track Faculty 39

Faculty in Leadership Positions... 12

Research Papers Published...172

Active Sponsored Research Projects 53

Technical Support Staff..7

Students Employed 65

Ph.D. Students 31

MS Students... 23

Undergraduate Students...1

Post-Docs...1

ITTC Expenditures by Income Source

Tech Comm 1%
State 20%
Industry 8%
Other 10%
Federal 61%

Federal
Other
Industry
State
Tech Comm

ITTC Offers Creative, Affordable Mobile App Development

ITTC researchers will work with businesses and organizations to develop innovative, customized, and secure mobile applications while giving students hands-on experience in the rapidly growing market.

By providing continuous access to e-mail, documents, and other information, smartphones and tablet computers enable people to work from anywhere. In addition to increased productivity, apps improve customer service and expand the customer base by monitoring inventory control, offering storefront sales, and providing additional services.

The Mobile Application Development Project grew out of talks ITTC's Director of Technology Commercialization **Keith Braman** had with entrepreneurs and business owners around the state who needed secure, reliable, and easy-to-use apps. ITTC investigator **Gary Minden**, an expert in web development with a long history of successful collaborations with industry, serves as director. ITTC researchers with expertise in Android and Apple operating systems will develop the apps.

Mr. Braman and Dr. Minden will meet with potential clients to gain a better understanding of the types of apps that would be most beneficial to them. The ITTC development team will work with clients on the functional and technical requirements to ensure ease of use, dependability, and security.

ITTC Information Specialist Leon Searl brainstorms ideas for the development of mobile applications, which can increase productivity, improve customer service, and provide additional efficiencies. Mr. Searl, who helped develop the iPhone app for Duet-on-Pitch, will be among the researchers working on ITTC's new Mobile Application Development Project.

The new endeavor will provide students with development experience in creating real-world applications. Initially, the collaboration will include students from computer science and graphic design. As the project grows, ITTC researchers hope to bring in students from business and marketing to assist in strategy and development. ▪

State Leaders Recognize Student Research for Aerospace Industry

ITTC doctoral student **Brian Cordill** was among the 33 graduate students from KU, Kansas State, and Wichita State who were selected to present their research and how it benefited Kansas to elected officials and the public at the Graduate Research Summit in February.

While airplanes made out of carbon composites use less fuel and are more durable, they can't protect sensitive electronic equipment like their aluminum counterparts. Metal provides a natural shield from weather, military, and other high-power radar signals that can jam equipment and cause other problems through electromagnetic interference (EMI).

Currently, manufacturers are unable to conduct EMI tests until a prototype is built, making changes costly and difficult. But under the direction of ITTC researcher **Sarah Seguin**, Cordill is using electromagnetic modeling software, developed in collaboration with **Mark Ewing**, director of KU's Flight Research Laboratory to identify possible EMI problems in the design phase.

"EMI is a pretty wide-open problem with a lot of research focused on identifying and fixing problems, but what companies really need now is a way to bring down costs," said Cordill. ▪

Dept. of Commerce to Support ITTC Economic Development Efforts

ITTC will be moving under the umbrella of the Kansas Department of Commerce (KDOC). This summer the Legislature voted to dissolve the Kansas Technology Enterprise Corporation (KTEC), and move many of its programs to KDOC. KDOC's broad involvement with industry will give ITTC increased access to companies across the state.

As the Center for Excellence in Information Technology, ITTC is charged with conducting innovative research and providing technical assistance with the overlapping aims of supporting new companies, strengthening existing businesses, and serving as an expert resource for other private and public partnerships. ITTC is one of four university-based Centers for Excellence across the state.

Keith Braman, director of ITTC's Office of Technology Commercialization, says that state funding is instrumental in the development and commercialization of internal projects with market potential and other activities.

ITTC executive staff look forward to meeting with KDOC representatives and showing them how ITTC benefits Kansans.

According to Kansas entrepreneur and ITTC Industry Advisory Board member **Marc Epard,** ITTC is a world-class research center and can help grow a more robust, diverse Kansas economy. Talented ITTC researchers are developing technologies that can be spun out into Kansas companies. These start-ups attract high-tech innovators and give ITTC alumni more opportunities to stay in the state. ▪

Kansas Business Seeks Data Entry Technology

Director of ITTC's Technology Commercialization **Keith Braman** negotiated an evaluation agreement for SmartXAutofill with Holland Technologies. The automated data entry system serves as an alternative to costly, error prone manual data entry. SmartXAutofill reduces the time and effort needed for data entry by making suggestions to data fields based on matches between values in past documents and the current document. The ITTC technology incorporates an ensemble predictor, integrating multiple predictive techniques into a single architecture.

Located in Baldwin City, Holland Technologies, Inc., is an information technology consulting firm that provides mission-critical IT business solutions and value-added IT professional services for its clients. Tom Holland, founder and president of Holland Technologies, is working with the Lawrence Regional Technology Center on a business plan for SmartXAutofill. ▪

The skills and expertise of ITTC technical staff members make them highly sought-after collaborators on projects across the University.

KU Research Advances Renewable Energy

ITTC Electronics Engineer **Daniel DePardo** assisted faculty and students from the KU School of Architecture, Design & Planning in incorporating the latest technologies into the new Center for Design Research (CDR), located on West Campus. According to CDR Director Gregory Thomas, Mr. DePardo and ITTC were instrumental in getting the building up and running. The CDR interdisciplinary research effort is aimed at developing management, human interface, and operational technologies for solar energy, wind turbine, and electric vehicle systems.

ITTC electronics engineer Daniel DePardo, left, and graduate research assistant Lakshmi Anusha Kosuru test technology being developed for Lawrence Livermore National Laboratory. Mr. DePardo's wide-ranging expertise allows him to collaborate on a number of KU research projects.

KU School of Architecture Distinguished Professor Dan Rockhill and his Studio 804 students consulted with Mr. DePardo to blend varied building technologies together into a cohesive system for the CDR. The development of CDR systems is expected to be an ongoing effort, with the facility serving as a test bed for new techniques and technologies. ▪

Bioinformatics and Computational Life-Sciences Lab

K nowledge of the human genome is revolutionizing medical and biological research. It will provide a new understanding of inherited diseases and how to treat them, along with improvements to overall health and aging. Bioinformatics will drive these breakthroughs by making sense of the data deluge. Novel BCLSL tools and methods focus on modeling, analysis, and data management. ■

Multidisciplinary KU Team to Develop Database to Assist in Climate Change, Evolution Research

A multidisciplinary team of KU researchers have received a $1.5 million grant from the National Science Foundation to develop a searchable online database and library that links the 50-plus volumes of the "Treatise on Invertebrate Paleontology," an important resource on climate change, evolution, and other biodiversity research.

"Treatise" classifies all known extinct and living invertebrates (creatures without backbones), which make up 95 percent of the animal species. Finding new ways to electronically extract, analyze, and store this authoritative compilation will lead to greater understanding of mass extinctions, evolutionary recoveries, and current environmental threats. Researchers from ITTC and KU's Paleontological Institute are creating the Invertebrate Paleontology Knowledgebase (IPKbase).

"IPKbase will help researchers more easily connect the dots," said BCLSL Director **Xue-wen Chen**, principal investigator of IPKbase. "The amount of information is overwhelming, and we are developing tools to help them mine data. By developing a fast and flexible online information repository, we will enable greater access to critical information."

KU researchers will develop a three-step process for IPKbase to handle the highly complex and immense "Treatise" data. Computational tools will extract and integrate images, text, and numerical data. For example, image-based searches will allow paleontologists to compare photographs of a newly discovered fossil with known images. New data analysis, modeling, and visualization techniques will discover patterns and provide meaningful interpretation. Finally, IPKbase will index information for easy retrieval and sharing.

ITTC investigators **James Miller**, **Jun "Luke" Huan**, **Bo Luo**, and **Brian Potetz** are co-investigators on IPKbase. ■

Construction on ITTC's Bioinformatics Computing Facility (BCF) will begin in August. More than 6,000 square feet in Nichols Hall will be renovated to enable a 20-fold boost in computing power.

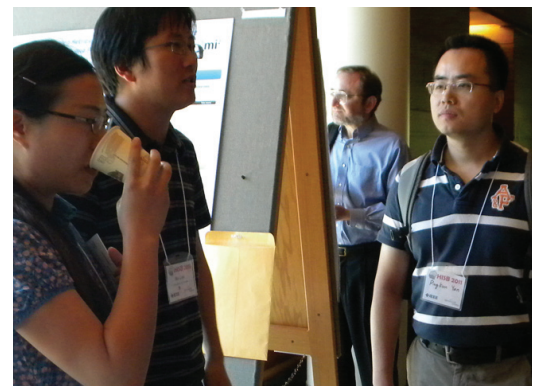# Chen Leads First IEEE Conference on Healthcare Informatics

B CLSL Director **Xue-wen Chen** was selected to co-Chair the first IEEE Conference on Healthcare Informatics, Imaging, and Systems Biology (HISB). Healthcare IT researchers are mining information to better understand the connections between symptoms, diseases, treatments, and outcomes. Advances in medical imaging and analysis are improving early diagnoses, and systems biology research will lead to personalized treatments. The union of HISB fields will revolutionize health care.

"The conference brought together leading researchers in HISB disciplines to present their cutting-edge work and to create a better understanding of diseases from each different, but potentially complementary, aspect," said Dr. Chen. "Leveraging our collective knowledge and experience, we hope to build important collaborations among the three communities to transform health care."

Two ITTC student papers were accepted for the conference. Graduate student **Yuxin Chen** presented his paper, "Cephalometric Landmark Tracing Using Deformable Templates." Cephalometric x-rays show dental and skeletal relationships, which are needed to diagnose genetic malformations and sleep disorders and plan and evaluate orthodontic treatments. ITTC investigators Xue-wen Chen, **Brian Potetz**, and **Bo Luo**, who serve as coauthors on the paper, and their students developed a robust algorithm that automatically detects and identifies anatomical landmarks on the X-ray images.

Undergraduate student **Jonathan Lutes** and doctoral student **Meeyoung Park** led a discussion of the paper "Healthcare Information Networks: Discovery and Evaluation." Drs. Luo and Xue-wen Chen were coauthors on the paper. Researchers constructed tools to analyze a network of healthcare information websites, evaluating their trustworthiness.

Dr. Luo and ITTC researcher **Jun "Luke" Huan** served as finance chair and systems biology program committee member, respectively. ∎

Top Photo: BCLSL Director Xue-wen Chen delivers opening remarks at the first IEEE Conference on Healthcare Informatics, Imaging, and Systems Biology (HISB).

Middle: ITTC graduate student Yuxin Chen, left, enjoys the banquet with a fellow student researcher.

ITTC investigators Fengjun Li , left, and Bo Luo, center, discuss their research with a fellow conference attendee.

Photos courtesy of Bo Luo and Yuxin Chen

Computer Systems Design Lab

T he Computer Systems Design Laboratory (CSDL) focuses on the development and implementation of complex, high-assurance embedded computer systems. CSDL researchers develop predictable, robust systems critical to the nation's economy, security, and quality of life. CSDL research provides advanced languages and techniques for compilation and synthesis, profiling and verification, and high-assurance and real-time performance. ■

ITTC will be hosting international conferences on Automated Software Engineering and Functional Languages this fall. These premiere conferences will bring hundreds of researchers and industry practitioners to campus—many for the first time.

ITTC Research Aims to Increase Ease, Affordability in Building High Assurance Computer Systems

T echnology being developed at ITTC will make it easier and cheaper to build highly dependable, secure software, potentially saving billions of dollars annually.

This summer ITTC researcher **Andy Gill** received a $500,000 National Science Foundation grant to streamline tools for the development of high assurance computer systems. The innovative support tools will provide greater transparency and scrutiny when building critical components for large complex systems, dramatically reducing the bugs and glitches that occur in current software.

When programmers build software, they first must determine how it will be used and then how it will function. They should then evaluate the software to ensure the description and function match, but this step is cumbersome and expensive.

All too often, crude testing methods are used instead, inadvertently neglecting to test critical corner cases that later result in bugs in real-world deployment. A National Institute of Standards and Technology study found that software defects cost the economy $60 billion annually and account for 80 percent of software development costs.

Dr. Gill is building the Haskell Equational Reasoning Model-to-Implementation Tunnel, nicknamed HERMIT, to improve software correctness. HERMIT mathematically, or formally, analyzes each step of development, providing rigorous connections between system requirements and the programming details of a real application. While system requirements and programs are typically written in two different computer languages and often evaluated in a third, HERMIT provides a common foundation that generates evidence that the description and action match. These continuous checks make it much harder for errors to be introduced, and HERMIT's precise documentation style allows any pesky bugs to be caught early in the process. ■

Middle School Students Will Learn From Working Scientist

ITTC doctoral student **Andrew Farmer** is going back to middle school—at least for a few hours each week—as part of his National Science Foundation (NSF) fellowship. He will lead hands-on activities in science, technology, engineering, and mathematics (STEM), aimed at igniting student interest in scientific study and careers.

The NSF Graduate STEM in K-12 Education (GK-12) Fellowship provides $30,000 and tuition for the 2010-2011 academic year. It supports one-year partnerships between graduate students and K-12 teachers to improve Fellows' teaching and communication skills, advance STEM education in schools, and provide role models for students.

The Shawnee Mission native hopes to encourage other Kansas kids to pursue careers in innovation. He will spend one day a week at Landon Middle School in Topeka and will mentor undergraduate students in the UKanTeach program, a research methods course at KU.

"Middle school is when many students seem to give up on science and math, saying 'I'm not a math person' or 'I'm never going to use this.' By showing students how math and science skills apply outside the classroom, in research and decision making, we hope to ignite their curiosity and develop the ability to ask good scientific questions and conduct research themselves," said Farmer.

At ITTC, Farmer is writing testing tools for the programming language Kansas Lava, which allows programmers to generate hardware designs via reusable software constructs—like Legos for programming. Kansas Lava makes it much easier to address hardware correctness, security, and performance. With the support of the GK-12 fellowship, Farmer will develop systems that enable higher level programming constructs into Kansas Lava components, increasing the range of abstractions available to programmers. Kansas Lava is under the direction of ITTC investigator **Andy Gill.**

ITTC doctoral student Andrew Farmer will be leading middle school students, like those above, in hands-on science, technology, engineering, and mathematics (STEM) activities as part of his NSF Graduate STEM in K-12 Education (GK-12) Fellowship.

"Andrew is a natural teacher as well as being a first-class researcher, and is an invaluable member of my laboratory," said Dr. Gill. "This fellowship is an ideal preparation for his academic career."

Farmer is the second ITTC student to receive the GK-12 Fellowship. ITTC doctoral student **Megan Peck** was awarded the fellowship in 2010. ∎

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>
> Andrew Farmer

Communications & Networking Systems Lab

P ioneering research on intelligent, agile communication systems has earned the Communications and Networking Systems Laboratory (CNSL) international acclaim. ITTC researchers are developing the foundation for the future wireless Internet. Shrewd use of the radio frequency spectrum will help bring high-speed Internet service to rural America and enable much larger and faster "hot spots." ∎

ITTC investigator James P.G. Sterbenz continues leading interdisciplinary research in the development of the future Internet. Independent reviewers have called Dr. Sterbenz' research one of the core strengths of the Center.

Increased Efficiency will Enable Wireless Networks to Support New Users, Additional Applications

L ingjia Liu does not need a crystal ball to know future wireless networks will need to support heavy traffic and provide reliable, secure service for time-sensitive and data-intensive applications, such as streaming video and web conferencing.
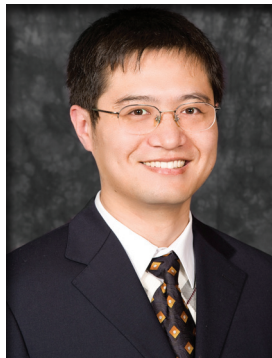
Dr. Liu, who will join ITTC this fall, focuses on inter-cell interference mitigation and delay-sensitive and energy-efficient wireless communication. His research aims to increase the overall spectral efficiency to support more users and applications.

He has made numerous technical contributions to major wireless standards, including 3GPP LTE/LTE-Advanced and IEEE 802.16m. He has conducted federally funded basic research and industry research, giving him experience in solving problems that have theoretical significance and practical importance.

Prior to joining KU, Dr. Liu spent more than three years in the Standards Research Laboratory of Samsung Telecommunications America. He received the *Global Samsung Best Paper Award* in 2008 and 2010, respectively. In 2011, the National Engineers Week Foundation selected Dr. Liu as one of its *New Faces of Engineering* and SAMSUNG Telecommunications America honored him with an *Individual Gold Medal*.

Dr. Liu is a member of the Phi Kappa Phi honor society and a member of IEEE. He is currently serving as an associate editor for the *EURASIP Journal on Wireless Communications and Networking* and Wiley's *International Journal on Communication Systems*. ∎

Deavours Holds Class at MIT, Shares RFID Expertise

ITTC investigator **Daniel Deavours**' world-class research has some prominent admirers. In September, he was invited to the Massachusetts Institute of Technology (MIT) to spend a week teaching and collaborating on radio frequency identification (RFID) technologies. Known as the next-generation bar codes, RFID tags enable more precise supply chain management, cargo tracking, and a host of other applications.

Wireless communication between a tag with identifying information and a reader can be corrupted if the tag is near metal or liquid. Dr. Deavours solved this long-standing problem with his Agility technology. The unique Agility design achieves typical read ranges more than three times that of other foam attached (FAT) tags on metal and outperforms them on cardboard and other RF-friendly materials. The Agility technology provides the performance of expensive asset tags but at the cost and simplicity of traditional FAT tags.

This leading-edge research led to Dr. Deavours' selection as the general co-Chair of the 2011 International IEEE Conference on RFID. The April conference in Orlando, Fla., offered more than 33 peer-reviewed research presentations, tutorials, poster sessions, and invited speakers. The premiere conference in RFID presents an open forum that facilitates dialogue between researchers and industry professionals on ongoing challenges and opportunities in RFID, which according to Global Industry Analysts will be worth an estimated $12.7 billion by 2015.

ITTC investigator Daniel Deavours welcomes attendees to the 2011 IEEE International Conference on RFID. Dr. Deavours has gained recognition for his world-class research in radio frequency identification (RFID) systems.

Photo by Daniel Arnitz

This spring Dr. Deavours began collaborating on the development of a passive RFID sensor system to monitor the human nervous system. After strokes or spinal injuries, some people lose the ability to sense bodily functions, such as needing to use the restroom. KU, University of Texas-Dallas, and Oklahoma State University researchers are working to develop an RFID system that monitors people's nervous systems and sends alerts. ∎

Fourth generation (4G) wireless networks split a signal into several narrowband channels at different frequencies to transport video, audio, and other massive data streams. It is common for sub-channels to go unused, which ITTC investigator **Victor Frost** and Ph.D. student **Zaid Hayyeh** are using to "cover" the transmission of covert messages.

Hayyeh received a travel grant to present their innovative research at the Military Communications Conference in November.

e-Learning Design Lab

The e-Learning Design Laboratory (eDL) is jointly sponsored by KU's Center for Research on Learning and ITTC. The lab explores new uses of technology to enhance teaching and learning. Its focus encompasses the development of new designs, tools, and policies that contribute to the evolution of e-Learning. ■

New Tool Helps Students Learn 3D Modeling

eDL co-Director **James Miller** always warns students in his Introduction to Computer Graphics course about the difficulty of their first 3D assignment. But students, being students, often ignore this warning. Starting well after office hours, exasperated students go online for help, only to find examples using advanced features that add to their confusion, says Dr. Miller.

To prevent blurry eyed, frustrated students from handing in incomplete assignments, Dr. Miller developed an easy-to-use, interactive tool, Metaview, that can run on any computer using Java Web Start. Metaview is packaged with a variety of self-test features and built-in 3D models to demonstrate major concepts.

The inspiration for Metaview came after Dr. Miller saw Tinker toys being used to show the relationships among the horizontal, vertical, and depth components in 3D models. He thought if the example could be more flexible and be embedded in a powerful interactive framework that it could help students better master the skills needed to create 3D models in medicine, architecture, engineering, animation, and other fields. Metaview does this, allowing students to better understand connections between models and programming constructs.

Dr. Miller has solicited anonymous student feedback from multiple Introduction to Computer Graphics courses. While the feedback has been positive, it exposed a few bugs that have been corrected and led to usability improvements in Metaview and a related website.

Work continues on Metaview. eDL researchers are developing a version that is compatible with computer tablets and other new smart, portable devices. To better understand the mathematics of lighting models, Dr. Miller is building tools that will allow interactive placement of light sources.

The work was supported in part by the National Science Foundation. ■

According to Ambient Insight Research, the worldwide market for self-paced e-Learning products and services reached $32.1 billion in 2010. Revenues are predicted to grow to $49.9 billion by 2015.

KU Collaboration Marks Successful First Decade

I n 2001, a long-standing collaboration between ITTC and the Center for Research on Learning was formalized with the e-Learning Design Lab (eDL). The early work of eDL focused on adult learners, including its successful Online Academy, whose teacher education programs have been adopted by over 175 universities. eDL soon expanded its target audience to K-12 students, with a special focus on enhancing the education of students with special needs.

eDL researchers began developing lessons and tutorials aligned with the federal standards in No Child Left Behind. They joined with the Kansas State Department of Education to create the Blending Assessment with Instruction Program (BAIP), which offers over 400 online tutorials aligned with federal math standards. BAIP, which has been used by more than 250 school districts in Kansas, including a large number of rural schools and parochial schools, offers online lessons and tutorials for students, management and monitoring tools for teachers, and resources for parents.

Another eDL success is "A Virtual Environment for Teaching Social Skills" (AViSSS), which helps middle school students with Autism Spectrum Disorders learn how to better interact with others and practice real-world situations independently. In collaboration with Associate Professor of Special Education Sean Smith, eDL co-Director **James Miller** designed and developed the virtual environment. ITTC doctoral student **Justin Ehrlich** was the lead developer on the project. In AViSSS, students encounter various everyday situations, such as someone accidently bumping into them in the hall or someone sitting in their favorite seat on the bus. If they choose the best response, they move forward. If not, an "inner voice" explains why the choice is incorrect and encourages them to try again.

eDL researchers aim to balance their innovative creation of online instruction with research that examines the tools and instruction within the field. The interdisciplinary lab involves more than 30 faculty, staff, and student researchers.

eDL co-Director and Professor of Special Education **Edward Meyen** says it is an exciting time to be a part of online learning. According to Ambient Insight, e-Learning reached $27.1 billion in 2009 and is predicted to nearly double that amount by 2014. In addition to online learning opportunities in K-12 through post-secondary education, Dr. Meyen points to online instruction for staff development and training in industry and other organizations as a high growth area. ■

Top photo: eDL co-Director Ed Meyen has been instrumental in providing online tutorials and units to thousands of K-12 students in Kansas.

eDL co-Director James Miller (left) and David Wolfe, a senior in computer science, discuss the redesign of an interactive tool that Dr. Miller developed to help students learn curve and surface design concepts.

Developed by eDL researchers, this virtual environment allows students with Autism Spectrum Disorders to practice social skills in everyday situations.

Information Assurance Lab

T he Information Assurance Laboratory (IAL) focuses on developing, verifying, and fielding high-assurance information systems. Its purpose is to provide a University-wide focal point for those involved in information assurance research, education, and implementation. IAL research includes theoretical modeling, high-assurance system synthesis and verification, security modeling and analysis, and network and database security. ∎

Li Develops Secure, Private Data Sharing Approach

W hile **Fengjun Li** does not wear a cape or possess superhero powers, she is nonetheless protecting people. Electronic medical records and smart grids are among the large multiuser systems that provide greater efficiency, reliability, and cost savings. But as these systems collect and store unprecedented amounts of personal data, how is individual privacy being protected?

Dr. Li, who will join ITTC this fall, is developing cryptography techniques that enable organizations to share data while maintaining user privacy.

For example, a smart grid collects data every few minutes. The information allows energy producers and users to make more informed decisions, but it also shows when a customer gets up, does laundry, goes online, leaves the house, and so on. Patterns emerge, such as when the house is vacant, that pose additional security concerns.
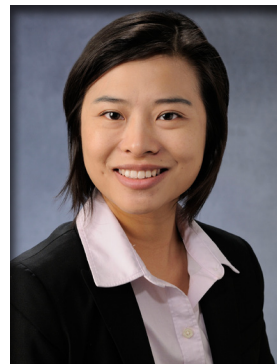
Dr. Li has developed an innovative in-network aggregation approach that cuts the network load by more than 60 percent compared to traditional approaches. Instead of sending data directly to collector devices, smart meters (SMs) form multi-hop routes via other SMs. Nodes along the way aggregate the received data with its own and forward the results to collector devices. Data aggregation spreads the operations and the computational efforts originally at collector devices into sets of nodes, which greatly reduces the network traffic. For additional security, Dr. Li employs homomorphic encryption that allows meaningful computations to be applied to already encrypted data. Privacy-sensitive data of individual households are protected not only at intermediate nodes but also at the collector devices.

She is applying her expertise in the secure and private sharing of data to smart grids, health informatics, social networks, and other distributed information systems. Dr. Li received her Ph.D. in Information Sciences and Technology from the Pennsylvania State University in 2010. ∎

ITTC researchers are developing security models to assess the information infrastructure of a Kansas energy company. ITTC works with Kansas companies to build stronger, more robust enterprises.

Austin Earns Department of Defense SMART Scholarship

Increasing the security and maintainability of computer systems has earned an ITTC graduate student in computer science a prestigious Department of Defense (DoD) scholarship.

Evan Austin, of Shawnee, will receive a $38,000 annual stipend, full tuition and fees, book allowance, and health insurance through the Science, Mathematics And Research for Transformation (SMART) Scholarship for Service Program. Austin, who will graduate with a master's degree in computer science this summer, will begin his doctorate studies at KU this fall.

"Evan has worked very hard and we're all very proud of him," said School of Engineering Dean **Stuart Bell**. "The home-grown talent at the KU School of Engineering continues to excel at the highest levels of scholarship and research. This award is a great honor and the work he's completing at KU will play an important role in the security of the information technology we all rely on."

SMART recipients receive paid summer internships and postgraduate employment within the DoD. The program, which aims to bring highly trained civilian scientists and engineers to DoD facilities, requires a year of employment in return for each year of scholarship.

"Beyond the generous financial benefits attached to the award, the SMART program provides years of invaluable experience at a DoD research facility," said Austin. "When I look at the incredible new professors EECS has gained over the last few years, I notice many are finding immediate success based on the contacts and confidence

ITTC graduate student Evan Austin works on research that will reduce the development time of trustworthy large-scale systems. This spring he received a prestigious Department of Defense SMART Scholarship.

that they developed working at government research labs. I'm hoping that this opportunity will provide me with a similar foundation that I can build upon for success."

At ITTC, Austin is developing formal reasoning tools that will allow researchers to build models that will evaluate the security, reliability, maintainability, and other importance facets of their hardware/software design. His tools are aimed at expediting the generation of trustworthy large-scale systems, such as smart grids and telecommunication networks.

"Evan is an exceptionally talented researcher and a wonderful member of my laboratory," said Austin's adviser, ITTC Director **Perry Alexander**. "The SMART fellowship suits him quite well, and I believe the experience he will gain working with the DoD will benefit him greatly when he starts his academic career. This fellowship is great for Evan and great for ITTC and KU." ∎

> "Evan has worked very hard and we're all very proud of him. The home-grown talent at the KU School of Engineering continues to excel at the highest levels of scholarship and research. This award is a great honor and the work he's completing at KU will play an important role in the security of the information technology we all rely on."
>
> — KU School of Engineering Dean Stuart Bell

Intelligent Systems Lab

T he Intelligent Systems Laboratory (ISL) is creating smarter and more user-friendly environments and devices. Comprised of sensors, software, and computers embedded in machines and devices, intelligent systems emulate and enhance human reason and action. Intelligent systems allow machines to anticipate requirements and deal with complex, dynamic environments. ◼

Intelligent systems add knowledge and reasoning to applications, databases, and environments, making them more sensitive to user behavior and changes.

Expert Panel Enables More Accurate Predictions

H ow can a rock be distinguished from a land mine in a sonar image, loan risk be determined from a credit application, or liver cancer identified from blood test results? A new classification algorithm, developed by ITTC investigator **Brian Potetz**, will help answer these difficult questions and others by more accurately predicting outcomes based on quantified data.

Using an innovative approach to classification, Dr. Potetz based the algorithm on statistical inference, which identifies the most likely outcome based on past results. It emulates a panel of experts, rather than a single expert as in past approaches, enabling the ITTC algorithm to outperform previous top algorithms.

Recently, Dr. Potetz teamed up with ITTC doctoral student **Meenakshi Mishra** and ITTC investigator **Jun** "**Luke**" **Huan** to apply the new algorithm to toxicity

prediction. Thousands of chemicals are used in pesticides, food additives, pharmaceuticals, and consumer products that need immediate toxicity profiling to understand their impact on human health and the environment, according to the Environmental Protection Agency (EPA).

The ITTC classification algorithm assigns chemicals to either Group A or Group B based on their various properties; those in the latter group will undergo further testing. While automated predictions will not replace all lab testing, Dr. Potetz hopes that one day it will replace the current method of using animals as test subjects.

The paper, "Estimating the Bayes Point Using Linear Knapsack Problems," detailing the new algorithm was published in the *Proceedings of the 28th International Conference on Machine Learning* held in June in Bellevue, Wash. The toxicity study will be presented at the IEEE International Conference on Bioinformatics and Biomedicine in November, with co-author Dr. Huan and lead author Mishra. ◼

Strategic Communication Maximizes Accuracy, Resources

If it looks like a duck, swims like a duck, and quacks like a duck, it probably is a duck.

T he simple duck test illustrates how the brain collects information from multiple senses, analyzes the data, and makes a logical decision in real time. Researchers are attempting to create advanced data gathering and analysis through an interconnected network of sensors. Combining data from multiple sensors—known as sensor fusion—provides a more detailed picture upon which to base decisions. For example, the integration of Computed Tomography (CT), Positron Emission Tomography (PET), and other medical images could better detect early-stage cancers and other diseases.

With sensor networks generating massive amounts of data, what would be the most effective and efficient way to exchange information? ITTC doctoral student **Christopher Redford** and ISL Director **Arvin Agah** have developed an innovative exchange in which sensor nodes share a simple summary, think of it as a thumbs up/down vote, with the network. If nodes agree, they do not communicate again until new data change their conclusions. The strategic communication minimizes costs and saves battery power. But if they disagree, the sensors provide the data that led to their conclusions, greatly increasing system-wide accuracy. The method employs computational argumentation, which has a myriad of applications in law, politics, business, engineering, and other fields, says Redford.

Redford tested the Evidentialist Foundationalist Argumentation (EFA) system against another multiagent system, which uses a Kalman Filtering approach, on weather data gathered by sensors. Each sensor node measures wind chill, wind speed, and visibility— predicators of a blizzard. Individual agents aim to provide the most accurate model of the current weather while maximizing resources. The EFA system was more accurate in detecting blizzards.
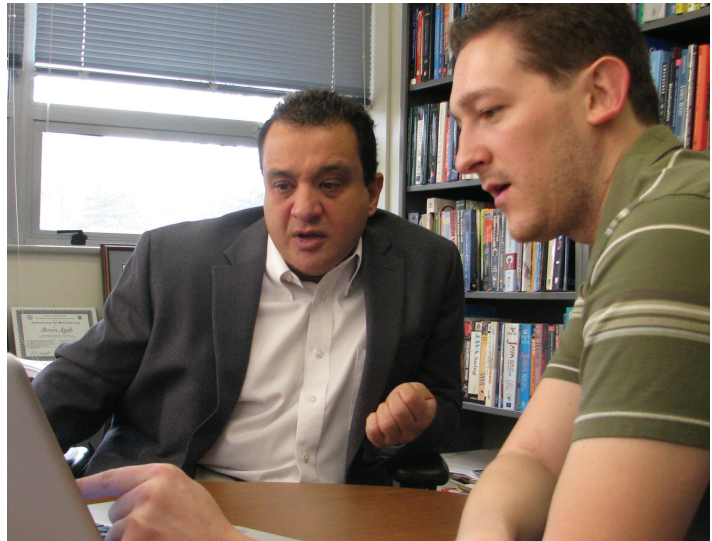
ISL Director Arvin Agah, left, and ITTC doctoral student Christopher Redford have developed an innovative exchange in which interconnected sensor nodes provide simple summaries to the network to minimize power and costs. But if nodes disagree, the sensors provide the data that led to their conclusions, greatly increasing system-wide accuracy.

"We were pleased to see the method perform as expected," says Redford. "While the Kalmin Filtering approach was formidable, its accuracy ratings were still lower in comparison. This is likely due to the precision with which the EFA approach strategically shares data between nodes. For future applications, I am most interested in seeing how the system can be used to precisely organize information for use in human-focused applications like education, politics, and law."

Redford presented his research paper, "A Framework for Evidence-Based Argument Construction and Evaluation Applied to Multi-Agent Sensor Webs," at the International Conference on Artificial Intelligence and Pattern Recognition in July 2010. His research will be published in the October issue of the *International Journal of Artificial Intelligence*. ∎

Radar Systems & Remote Sensing Lab

R SL is widely respected for its radar remote sensing research, which includes the well-known radar modes of imaging, detection, and tracking. Researchers investigate signal processing and system-level approaches to solving radar problems. They explore potential new modes of radar operation, the combining of radar with other modalities, such as low probability of intercept communications, and the optimization of exotic new radar waveforms and antenna structures. ■

ITTC doctoral student Brian Cordill was selected to present his research at the Capitol Graduate Research Summit this winter. His electromagnetic interference research will save time and money for the Kansas aviation industry.

Expert in Electromagnetic Compatibility Joins RSL

E ECS Assistant Professor **Sarah Seguin** joined RSL in January. Dr. Seguin is an expert in electromagnetic compatibility (EMC), which ensures electronic systems function as designed, without malfunction or performance degradation due to interference.

With the proliferation of smartphones, computer tablets, and other wireless devices, electromagnetic interference (EMI) is a growing problem. Unintended emissions can disrupt airplane instrumentation in flight, cause pacemakers to malfunction, or result in other potentially disastrous consequences. Dr. Seguin's research examines how to stop EMI at the source, and if emissions are unavoidable, she develops advanced shielding techniques to minimize EMI.

Dr. Seguin is working with Wichita-based aerospace companies to determine the shielding effectiveness of carbon composites. The lightweight material

ITTC investigator Sarah Seguin explains potential interference points to her Electromagnetic Compatibility class during a field trip to the Lawrence airport this spring.

can reduce fuel consumption by nearly 20 percent, and it offers greater durability and design flexibility than aluminum. But carbon composites have yet to protect sensitive electronic equipment like their aluminum counterparts.

Currently, manufacturers are unable to conduct EMI tests until a prototype is built, making changes costly and difficult. But Dr. Seguin and her students are using electromagnetic modeling software to identify possible EMI problems in the design phase, saving manufacturers time and money in production. The software was developed in collaboration with **Mark Ewing**, chairman of the Department of Aerospace Engineering and director of the Flight Research Laboratory. ■

International Radar Conference Comes to Tornado Alley

F or the first time, the prestigious IEEE Radar Conference was held in Kansas City, and the theme, "In the Eye of the Storm," acknowledged the importance of radar in tracking severe storms. As if on cue, small tornadoes passed through the metro during the May 23-27 conference. ∎

KU was selected to lead the conference, and ITTC researcher **Shannon Blunt** and ITTC Associate Director **James Stiles** served as the General Chair and General co-Chair, respectively. Professor Emeritus **Richard Moore**, the founder of the KU Radar Systems Lab and a pioneer of radar remote sensing, was the Honorary Chair. More than 20 KU faculty, students, and alumni participated in all aspects of the conference.

"This is the most prestigious conference in the world dedicated solely to radar, and it's a great honor for KU to serve in this capacity," said Dr. Blunt. "People sometimes mistakenly think of radar as 'old technology'… but so is the telephone. The digital revolution has led to things like smart phones, and we're now starting to see similar advances for sensor technologies such as radar."

More than 400 scholars and industry practitioners from 28 countries exchanged ideas through technical presentations, poster sessions, tutorials, and industry exhibits.

"The 2011 IEEE Radar Conference hosted by the University of Kansas was one of the best conferences I have attended," said Lt Col **Geoffrey Akers**, an assistant professor in electrical engineering at the Air Force Institute of Technology Wright-Patterson Air Force Base and KU alumnus. "It was well-organized, covered a broad range of topics, and the title of the conference [In the Eye of the Storm] could not have been more timely." ∎

"**People sometimes mistakenly think of radar as** '**old technology**'**… but so is the telephone. The digital revolution led to things like smart phones, and we're now starting to see similar advances for sensor technologies such as radar**."

—ITTC researcher Shannon Blunt

Top Photo: (l to r) ITTC researcher and General Chair Shannon Blunt, Jason Fritz of Colorado Engineering Inc., and KU alumnus William Blake chat before the Banquet.

ITTC investigator and Technical co-Chair Christopher Allen (left)and ITTC Industry Advisory Board Member Eric Mokole, of the U.S. Naval Research Laboratory, enjoy dinner before the Banquet Awards. At the banquet, Dr. Mokole was recognized for his recent elevation to IEEE Fellow.

ITTC Associate Director and General co-Chair James Stiles served as the host of the Awards Banquet.

Photos courtesy of Tim Lee

ITTC Principal Investigators

Arvin Agah
Professor, EECS; Director, Intelligent Systems Lab
Intelligent systems; robotics; medical applications of Artificial Intelligence; software engineering

W. Perry Alexander
Professor, EECS; Director, ITTC; Director, Computer Systems Design Lab; Director, Information Assurance Lab
Systems-level design; formal specification and verification; IP reuse; specification and programming languages

Christopher Allen
Professor, EECS; Radar Systems and Remote Sensing Lab
Microwave remote sensing; radar system design and analysis

Ronald Aust
Associate Professor, Educational Leadership & Policy Studies; e-Learning Design Lab
Designing and developing multi-state educational networks and technologies to support collaborative learning

Shannon Blunt
Associate Professor, EECS; Radar Systems and Remote Sensing Lab
Adaptive signal processing; interference cancellation; multistatic radar

Swapan Chakrabarti
Associate Professor, EECS; Bioinformatics and Computational Life-Sciences Lab; Intelligent Systems Lab
Neural networks and fuzzy systems in bioinformatics; signal processing; True 3-D display systems

Xue-wen Chen
Associate Professor, EECS; Director, Bioinformatics and Computational Life-Sciences Lab; Intelligent Systems Lab
Bioinformatics; human-computer interaction; machine learning; statistical data analysis

Daniel Deavours
Research Associate Professor, ITTC; Computer Systems Design Lab; Communications and Networking Systems Lab; Information Assurance Lab
RFID privacy and security design and development; low-profile, planar, UHF RFID tag technology; performability modeling specification

Kenneth Demarest
Professor, EECS; Radar Systems and Remote Sensing Lab
Computational electromagnetic techniques; lightwave systems

Tyrone Duncan
Professor, Mathematics; Communications and Networking Systems Lab
Stochastics of mathematical finance; applied mathematics seminar; differential equations; probability theory

Joseph Evans
Deane E. Ackers Distinguished Professor, EECS; Communications and Networking Systems Lab; Information Assurance Lab
Networks; ubiquitous computing environments; adaptive systems

Mark Ewing
Chair, Aerospace Engineering; Director, Flight Research Laboratory; Radar Systems and Remote Sensing Lab
Structural vibrations of high performance structures; aircraft structural acoustics and interior noise reduction

Jianwen Fang
Director, Applied Bioinformatics Lab; Bioinformatics and Computational Life-Sciences Lab
Genomics using statistical and machine learning approaches; structure prediction; function annotation/prediction; sequence and domain analysis of proteins; phylogenetic analysis

Victor Frost
Associate Chair Graduate Studies and Dan F. Servey Distinguished Professor, EECS; Communications and Networking Systems Lab
Internet QoS, traffic management; integrated broadband networks

Xin "Felicity" Fu
Assistant Professor, EECS; Communications and Networking Systems Lab
Computer architecture; hardware reliability; impact of nano-scale technology scaling on multi-core processors; on-chip interconnection network

Andy Gill
Assistant Professor, EECS; Computer Systems Design Lab; Information Assurance Lab
Functional languages and technologies; software engineering; compilers; systems; FPGAs

Jerzy Grzymala-Busse
Professor, EECS; Intelligent Systems Lab; Bioinformatics and Computational Life-Sciences Lab
Data mining; machine learning; rough set theory

Jun "Luke" Huan
Assistant Professor, EECS; Bioinformatics and Computational Life-Sciences Lab; Intelligent Systems Lab
Bioinformatics; data mining; machine learning; statistical data analysis

Rongqing Hui
Professor, EECS; Communications and Networking Systems Lab; Bioinformatics and Computational Life-Sciences Lab
Optical communication systems; photonic devices; optical measurement and sensors

Prasad Kulkarni
Assistant Professor, EECS; Computer Systems Design Lab
Static and dynamic/adaptive compilers; embedded systems; machine learning; computer architecture

Bo Luo
Assistant Professor, EECS; Intelligent Systems Lab; Information Assurance Lab
Information security and privacy; XML and conventional database systems

Gerald Lushington
Director, Molecular Graphics and Modeling Laboratory; Bioinformatics and Computational Life-Sciences Lab
Computational simulation of the behavior of chemical systems; computational chemistry; biochemistry and materials science

Jeremy Martin
Associate Professor, Math; Information Assurance Lab
Combinatorics; discrete geometry

Ed Meyen
Professor, Special Education; co-Director, e-Learning Design Lab
Online instructional design; web tools; emerging instructional technologies

James Miller
Associate Professor, EECS; co-Director, e-Learning Design Lab; Computer Systems Design Lab
Visualization, geometric and solid modeling for computer-aided design; computer graphics

Gary Minden
Professor, EECS; Director, Communications and Networking Systems Lab; Information Assurance Lab; Computer Systems Design Lab
Digital systems; microprocessors; artificial intelligence

Douglas Niehaus
Associate Professor, EECS; Computer Systems Design Lab; Intelligent Systems Lab
Real time, conventional distributed systems; operating systems; high performance networking

Bozenna Pasik-Duncan
Professor, Mathematics; Courtesy Professor, EECS; Communications and Networking Systems Lab
Stochastic adaptive control and Mathematics and Science education

Erik Perrins
Associate Professor, EECS; Communications and Networking Systems Lab
Digital communication theory; advanced modulation techniques; channel coding; MIMO

Dave Petr
Associate Chair Undergraduate Studies and Professor, EECS; Communications and Networking Systems Lab
Performance analysis; traffic integration; congestion control; resource management; QoS

Brian Potetz
Assistant Professor, EECS; Intelligent Systems Lab
Computer vision; machine learning; computational Neuroscience and natural scene statistics

Glenn Prescott
Chair and Professor, EECS; Radar Systems and Remote Sensing Lab; Communications and Networking Systems Lab
Digital signal applications and low probability of intercept communication

Hossein Saiedian
Associate Chair Edwards Campus and Professor, EECS; Computer Systems Design Lab; Information Assurance Lab; Intelligent Systems Lab
Software architecture; software processes, management; agile software development

Sarah Seguin
Assistant Professor, EECS; Radar Systems and Remote Sensing Lab
Electromagnetic compatibility; unintentional and intentional electromagnetic interference; radar systems; signal integrity; antenna design

K. Sam Shanmugan
AT&T Distinguished Professor, EECS; Communications and Networking Systems Lab
Channel modeling; WCMA over satellite links; simulation of communication systems

James P.G. Sterbenz
Associate Professor, EECS; Communications and Networking Systems Lab; Computer Systems Design Lab; Information Assurance Lab
Survivable, resilient, disruption tolerant networking and programmable, active networks

James Stiles
Associate Professor, EECS; Associate Director, ITTC; Director, Radar Systems and Remote Sensing Lab
Radar remote sensing and propagation; scattering of electromagnetic waves in random media ■

The ITTC Vision

To be a global leader

and strategic partner

in the creation and

commercialization of

innovative technologies

in telecommunications,

information systems,

bioinformatics, and radar.

KU INFORMATION
& TELECOMMUNICATION
TECHNOLOGY CENTER
The University of Kansas