The Link

NEWS FROM KU INFORMATION & TELECOMMUNICATION TECHNOLOGY CENTER
The University of Kansas

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Chen Accepts August Award from NSF

ITTC Investigator **Xue-wen Chen** has received a prestigious Faculty Early Career Development (CAREER) award from the National Science Foundation (NSF). One of the highest honors conferred by NSF, the CAREER award recognizes promising junior faculty members who will likely become the academic leaders of tomorrow.

The multiyear award funds recipients' burgeoning research programs and the integration of their research and teaching. Chen is generating advanced computational techniques that examine and analyze immense biological data sets. The expansive study of biological networks will give researchers an unprecedented "big picture" view of humans' internal processes.

Technology had limited molecular biologists to a "one gene/protein in one experiment" basis. But with the relatively recent development of high-throughput technologies, it is now possible for life-sciences researchers to gain system-level understanding of complex biological systems and processes. To uncover these biological networks within the vast amounts of biological data poses one of the greatest scientific challenges of the modern era.

Chen is designing well-defined instructions, or algorithms, that will use classification, clustering, statistical modeling, and other aids to extract patterns from the massive high-throughput data sets. Also, algorithms will reconstruct complex biological networks, such as cell cycle pathways. By integrating knowledge

ITTC Researcher Xue-wen Chen examines research findings. Chen is developing tools to analyze biological data. He recently was awarded an elite NSF CAREER award, which recognizes promising junior faculty.

"learned" from their experiences and observations, machine learning methods will continue to improve in efficiency and effectiveness. ITTC research will produce this user-friendly software for life-science applications.

Chen's machine learning methods will have various applications within life sciences, including uncovering large-scale biological networks and inferring genetic regulatory networks. Powerful tools will analyze gene expressions for cancer classification. For example, genes, in effect, have "on/off" switches. Life-science research is examining what initially triggers these switches and how altered expressions affect other molecules. ITTC research is also identifying biomarkers, which are biochemicals in the body that are measured to detect a disease or to monitor the effects of treatment.

The CAREER award will give ITTC student research assistants opportunities to receive special training in bioinformatics. ■

Living Cells to Receive Closer Inspection

Advances in imaging and microscopic technologies are giving scientists a broad view of biological systems. New techniques, such as two-photon microscopy, produce three-dimensional (3D) images of living cells in thick tissues and live animals at greater depths and higher resolutions than traditional tools. Fluorescent labels are attached to samples,and the labels are then activated by two-photon excitation. Via this fluorescent microscopy technique, scientists have observed cell development in hamster embryos, measured calcium in the brains of mice, and monitored the mechanisms in rats' hearts.

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Director's News

ITTC is progressing on all three fronts of its mission—research, education, and technology transfer. ITTC Investigator **Ron Hui** has received funding from the National Institutes of Health (NIH) for a multidisciplinary research project, featured on page 1. Hui is leading this effort with collaborations from KU Medical Center in the development of a laser system that will reduce the costs for scientists to microscopically examine biological systems; reduced costs will enable wider use of the technology. Fellow ITTC Bioinformatics Researcher **Xue-wen Chen** has received a prestigious National Science Foundation (NSF) CAREER award, which recognizes young investigators who excel at both research and education. For more on Chen's award, please see page 1. This fusion of research and education has brought accolades to ITTC student researchers as well. **Levi Pierce** won first place in the KU Graduate Engineering Association (GEA) Research Poster Competition; his poster highlighted his bioinformatics work with ITTC Investigator **Terry Clark**. **Arvin Agah**, ITTC researcher and associate professor of EECS, taught a Software Development Lifecycle course, using ITTC Internet videoconferencing facilities. Cerner Corporation staff lectured students via the same facilities, and the company also held a multi-university design competition, which KU won. Students from KU, Kansas State University, the University of Iowa, and Purdue University developed software for a PDA to be used by healthcare providers. The Cerner competition united all three parts of our mission. ITTC will continue to facilitate a broad range of life-sciences activities, as we build momentum for our growing bioinformatics thrust area.

Director Victor Frost

ITTC has secured high-profile projects in our traditional areas of expertise. ITTC Investigators **Joseph Evans** and **James Sterbenz** received highly competitive NSF Future Internet Design (FIND) grants. Find more information on page 3. Sterbenz is conducting networking research for Sprint as well; the public-private partnership between KU and Sprint is in its second decade.

We strive to strengthen each part of our mission, so that ITTC may be a valuable resource for research, education, and technology transfer. ■

Sterbenz, Sprint Nextel Collaborate on Context-Based Network Project

It is becoming common to have a mobile device that contains multiple radios; e.g., 802.11, cellular, and Bluetooth. Different emerging applications have varying network requirements, by which they may be able to select the radio technology that best matches their needs. The selection of the appropriate infrastructure drives the need for "context-based" networking, in which the application, access technology, and backbone network context all contribute to quality of service (QoS) and policy-based routing. The selection of the appropriate network path depends on a complex set of factors.

To efficiently meet the increasing demands on wireless devices and their networks, ITTC Investigator **James P.G. Sterbenz** is conducting basic research on new technologies that will enable this context-based networking, with support from Sprint-Nextel. This project is synergistic with the "ResiliNets: Multilevel Resilient and Survivable Networking" initiative, in which KU and Lancaster University researchers are exploring principles, architecture, and mechanisms for achieving network resilience, including the diversity in paths and mechanisms needed for the Sprint Nextel-funded "Context-Based Networking" project. ■

Information and Telecommunication Technology Center
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Michelle Ward, Public Relations and Marketing Manager, mward@ittc.ku.edu
Nancy Hanson, Editor, hanson@ittc.ku.edu
Victor Frost, Director, frost@ittc.ku.edu

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2335 Irving Hill Road Lawrence, KS 66045-7612
Telephone: 785-864-4896 Fax: 785-864-0387
info@ittc.ku.edu http://www.ittc.ku.edu

Researchers Capture Pair of NSF FIND Awards

Two ITTC projects were among the first funded by the National Science Foundation's new Future Internet Design (FIND) initiative. FIND advocates a "clean-slate approach" to the development of a new, innovative global network. Researchers supported by FIND are not bound by current limitations of the Internet and thus are focusing on the design of an ideal network. Tomorrow's network will include greater security and greater functionality than the present network. ITTC Investigators **Joseph Evans** and **James P.G. Sterbenz** are helping lay the groundwork for this smarter, more robust network.

Cognitive radios promise to be the workhorses of the future network. Nimbly navigating the radio frequency (RF) spectrum, cognitive radio nodes sense and react to their environment. They seek out unused spectrum and negotiate use of these vacant frequencies with other, nearby wireless devices. Their intelligence and dexterity allow cognitive radios to jump channels without interfering with existing users, such as television broadcasts. These radios will enable more efficient use of the spectrum and prevent the traffic jams now occurring among wireless devices.

Evans' FIND project is developing the structure and protocols, or "code of conduct," for cognitive radios. ITTC investigators are designing control and management functions for cognitive radios, including their interactions on local and global network levels. Research will lead to an open-source cognitive radio software protocol stack (CogNet), which will be evaluated on emerging cognitive radio platforms. The "NeTS-FIND: CogNet—An Experimental Protocol Stack for Cognitive Radio Networks and Its Integration with the Future Internet" project is in collaboration with Rutgers University and Carnegie Mellon University. Researchers will test these new types of wireless networks on unlicensed, unused frequencies.

Sterbenz is collaborating with The University of Maryland and the University of Kentucky on the "NeTS-FIND PostModern Network Architecture (PoMo)" project. Its overall goal is to design a new thin internetworking layer that serves to bridge various realms of the future "Internetwork," each of which may have disparate mechanisms, policies, and trust relationships. PoMo will admit heterogeneity not possible in the current Internet, including mobile, wireless, ad-hoc, and sensor network realms that do not use Internet Protocol (IP) as the network layer mechanism. PoMo also explicitly recognizes trust and policy relationships between realms. Each PoMo inter-realm packet contains fields for forwarding, motivation, accountability, knobs, and dials. The latter two will be used for cross-layer optimizations, which will be areas of concentration for KU. KU researchers will also be concerned with the resilience and survivability of the architecture, in conjunction with the ResiliNets initiative in collaboration with Lancaster University. (See "Sterbenz," pg. 2.) ■

Living Cells to Receive Closer Inspection

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Laser-based scanning microscopy also reduces photo damage, permitting study over longer periods of time. However, the high cost and cumbersome size of the ultrafast laser needed for two-photon microscopy severely limits its practical applications.

ITTC Investigator **Ron Hui** is leading multidisciplinary research to develop an affordable, compact laser system that will increase the accessibility of this powerful imaging tool. The National Institutes of Health (NIH) is sponsoring the ITTC project, entitled "Portable and Wavelength-Tunable Two-Photon Microscopy."

Hui's team is developing a near-infrared light source, called two-photon, fiber-laser excitation (TP-FLEX), that will simplify the generation of optical pulses needed for two-photon microscopy. An ultrafast laser emits pulsed light, or photons, that excite fluorescent labels, permitting researchers to detect specific cells. TP-FLEX will integrate a fiber laser and tunable fiber-optic wavelength shifter, which can easily be attached to biological imaging microscopes that have high-quality lenses. In conventional two-photon microscope systems, large lasers are used, limiting mobility (and therefore use) of the system. The ITTC system, which uses a much smaller fiber laser, is easily transportable. The wavelength tunability of TP-FLEX will allow rapid imaging of the same region at different wavelengths, enhancing imaging capabilities. TP-FLEX permits the simultaneous monitoring of different biochemical functions through multicolor labeling. For example, with bioflourescent markers attached to specific proteins, various protein and molecular configurations can be distinguished and observed. Scientists can observe multiple cellular events at the same time.

The research combines investigators from KU and KU Medical Center with expertise in fiber-optic devices, biophysics and spectroscopy, and cell biology and microscopy. ■

Achievements and Acclaim

Hui Serves as Federal Program Manager

ITTC Investigator **Ron Hui** is directing the Photonics and Device Technologies Program within the National Science Foundation (NSF). Hui is the fourth ITTC faculty member to serve as a federal program manager. EECS Professors **Joe Evans**, **Glenn Prescott**, and **Gary Minden** have overseen programs at NSF, NASA, and DARPA. ■

Alexander's Rosetta Textbook is Published

Perry Alexander, director of ITTC's CSDL, has written the textbook *System-Level Design With Rosetta*, published by Morgan Kaufmann. The book examines the system-level design language, providing clear code examples and case studies. A review of the book by *Electronic Design* can be found online at www.elecdesign.com/Articles/ArticleID/14417/. ■

Pierce Wins Research Poster Competition

Levi Pierce earned first place in the master's division of the KU Graduate Engineering Association (GEA) Research Poster Competition, held on November 17. His poster, "Determining Contiguous Regions of DNA Response in Nucleosomes as a Foundation for a Computational Model," highlighted his research with ITTC Investigator **Terry Clark**. ■

Deavours Receives Best Paper Award

Daniel Deavours, ITTC research assistant professor, won the Best Paper honor at the International Conference on Computing, Communications and Control Technologies, CCCT'06, for his "A Novel Planar Microstrip Antenna Design for UHF RFID" paper. ■

ITTC LABORATORIES

Bioinformatics and Computational Life-Sciences Lab (BCLSL)

Communications and Networking Systems Lab (CNSL)

Computer Systems Design Lab (CSDL)

e-Learning Design Lab (eDL)

Intelligent Systems Lab (ISL)

Radar Systems and Remote Sensing Lab (RSL)

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ITTC Technology to Improve Military Safety Checks

Before new military technologies are ready for field use, they must first go through a thorough test and evaluation phase. On a test range, the "test article," such as a new aircraft, is outfitted with numerous sensors that generate large volumes of data. While the test is in progress, information is transmitted over a wireless telemetry link to a ground station, where it is processed and evaluated. The demand for higher data rates, coupled with a shrinking spectrum allocation, has created a new challenge for these telemetry links. ITTC research aims to improve bandwidth and power efficiencies on these links, which will enhance the overall quality of the received data. The U.S. Air Force is funding the "New FEC Schemes for Aeronautical TM" project.

Forward error correction (FEC) codes offer improved power efficiency. The principle behind these codes is that the transmitter adds a certain amount of redundant data to the transmitted message. When errors are made at the receiving end, the redundant data can be used to correct them.

ITTC Researcher **Erik Perrins** is developing FEC schemes where the telemetry modulation itself is treated as a code, allowing large coding gains with minimal bandwidth expansion. Previous approaches treated the modulation and demodulation functions independently from the coding scheme. Perrins exploits the memory inherent in the modulation and makes it possible to achieve extremely large coding gains, on the order of nine decibels. Such performance gains can extend the operating range of the modulations and improve the data quality with little additional bandwidth. These FEC schemes can be used in traditional and packet-based telemetry links. ■