



BEYOND THE EDGE





ADVANCING THE SCIENCE OF

WHAT'S NEXT.

Cities want to be on the leading edge. Companies want to stay on the cutting edge. And everyone, it seems, is looking for the competitive edge.

But to achieve these goals, somebody has to go beyond the edge into unknown territory to explore new possibilities, make new discoveries, and develop the next generation of emerging technologies. This is the work of the FedEx Institute of Technology at the University of Memphis.

We coordinate and fund world-class research. We offer a dynamic community for the collaboration and exchange of new ideas. And we foster strong relationships with businesses and community partners throughout the region who know the value of innovation using emerging technologies and understand the advantages of being first.

So come and join us beyond the edge, and see just how exciting the future can be.





Welcome to the future.

The FedEx Institute of Technology has had an exciting twelve months as a revitalized and dynamic innovation engine, both within the university and in the larger technology environment of the Mid-South. It strengthened its support for the university's most successful interdisciplinary research group, the Institute for Intelligent Systems, as well as the NIH-funded Mobile-Data-to-Knowledge (MD2K) Center of Excellence, which represents our most high-profile research cluster and truly positions the university as a significant global player in cutting-edge technology research. Both groups occupy the bulk of the collaborative research space in our futuristic modern building.

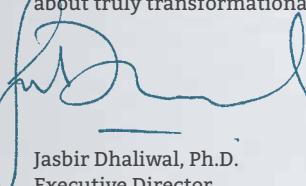
Working closely with our primary research sponsor, FedEx Corporation, we also successfully launched four new interdisciplinary research clusters in the areas of cyber security; biologistics; big data; and drones, robotics, and navigation-enabled systems. We seed-funded 34 exciting new research projects involving 44 faculty researchers from 17 colleges and schools across campus. These exciting projects are wide-ranging and include strengthening the security of cloud computing, developing aerogel packaging solutions for cold-chain logistics, designing secure information-sharing protocols for autonomous vehicles, and using additive manufacturing for repairing damaged metallic parts of robots and drones. The scope of these and other projects helps put the larger Memphis region on the map for innovative technology applications.

Taking seriously our role as the primary advanced technology research organization in our region, we launched a new innovation program to bring exciting emerging technologies and related competencies to our regional innovation environment. As part of this, we organized initiatives in all of these areas:

- Blockchain technology applications
- Virtual reality/immersive environments
- Big data analytics
- Scientific programming
- Unmanned and autonomous system applications and safety
- The utilization of mobile cameras for creative filming
- Advanced cyber security methods

We are convinced that these initiatives will help our regional corporate partners and start-up incubators/accelerators move faster and smarter toward the latest technological advances.

The technology innovation environment today reminds me of the excitement of the mid-1990s when society was newly discovering the transformational power of the Internet to change our lives forever, a time that sprouted a host of innovative new companies. It is critical for the university to lead our region in this coming new wave of converging innovation that will involve all the diverse technologies that our researchers are working with on a daily basis. Come partner with us at the FedEx Institute of Technology on this transformational innovation journey that is going to bring about truly transformational change.



Jasbir Dhaliwal, Ph.D.
Executive Director
FedEx Institute of Technology



WHAT'S NEXT?

It's a question the FedEx Institute of Technology asks every day. To answer it, we create and support groundbreaking interdisciplinary Research Innovation Clusters at the University of Memphis.

Made up of leading researchers from departments across the campus, these clusters are committed to addressing a wide range of technological issues that are critical to the success of our community and corporate partners—everything from preventing cyber theft to advancing the science of robots.

Cluster members work together to apply for research funding, seek external research partners, and create training and certification programs for the community. All the while, our clusters find ways to encourage junior and senior faculty, students, and community organizations to contribute their ideas and to be a vital part of the conversation.

In 2015-16, four new clusters were created, and the institute began fueling their research. Here, you can check out some of the exciting work initiated over the past year.



BEYOND THE FIREWALL

Cluster for Advancement in cyber Security & Testing (CAST)

CAST is made up of 22 researchers from 7 colleges and 11 academic departments working together to address one of the biggest challenges of our day: keeping online data secure from cyber theft. With threats becoming increasingly more sophisticated, CAST is stepping up research, working on the front lines of the cyber war to provide new solutions and software testing expertise that will help protect corporations, Tennessee government agencies, and the Department of Defense.

WHAT'S NEXT in cyber security.

In November 2015, the Institute funded 12 research projects, which are currently underway. The goals of these projects are as varied as they are far-reaching. Here are some highlights.

○ RELAY RACE

Protecting the smart grid from hackers

Investigation and Testing of Cyber Security - Protective Relay System of Smart Power Distribution Grid

Dr. Mohd Hasan Ali, Dr. Dipankar Dasgupta

The signals and commands used for remote monitoring and control of power distribution grids can be vulnerable to hackers, resulting in the loss or delay of data critical to efficient grid operation. Drs. Ali and Dasgupta are leading a team to explore this security threat and to develop a protective relay system that can prevent cyber attacks. "The relay technology we develop will help transform our existing power grids into future smart grids that are resilient and reliable," Dr. Ali says.

○ CYBER SENSE

Discovering how computer users react to security warnings

Technology Dependency Perspectives on Cyber Security Failures

Dr. Thomas Stafford, Dr. Sanderford Schaeffer

Understanding human behavior is critical to the success of cyber security-related warnings. Drs. Stafford and Schaeffer have teamed up to study the effect fear-inspiring messages have on Internet users, ones that warn of likely consequences from not engaging in pro-security behaviors. According to Dr. Stafford, people take their computer safety for granted. They generally expect that the technology they use will protect them. "They are wrong," he says. "The confluence of social media, artificial intelligence, and quantum computing will present new and unexpected threats to personal computing security, so a vigilant mindset to computer use is ever more important as we move forward."

The researchers are conducting their study in a special neuro cognitive lab that allows them to watch how people react to their computers and security threats and gather information they could not obtain from traditional surveys.

○ GAME CHANGERS

Making security compliance fun

The Effects of Gamification on Security Compliance Under Conditions of Social Engineering

Dr. Bill Kettinger, Dr. Chen Zhang, Dr. Jong Lee

How can companies ensure that their employees comply with security rules and regulations? Drs. Kettinger, Zhang, and Lee think making a game of it might be just the answer. They are looking at how "gamification," the use of game-inspired techniques, influences security compliance among employees.

Traditional security awareness training offered by organizations can be boring and tends to have only a short-term effect on employees' behavior, according to Kettinger. "We believe our research will show that gamification is a more fun and engaging way to improve security awareness and compliance," he says, "and it will have a more sustainable and long-term effect."

○ TOP SECRET

Streamlining the classification of government documents

Automated Document Classification - Sensitive Information Disclosure

Dr. Zhuo Lu, Dr. Su Chen

In today's information systems, data documents are generated every day in large volumes. There is a growing need to ensure that sensitive information for government and business operations are classified correctly, properly secured, and disseminated only to people with the proper security clearance. With so much data being generated, manual classification of documents has become a huge burden. That, in turn, prevents efficient data processing and management, increases the chance of human error, and increases risk.

Drs. Lu and Chen are developing a new, automated approach to security classification of government and business documents using statistical models, big data analytics, and cyber security technologies. With their new approach, they hope to not only make classified documents more secure but also streamline the entire classification process.



○ HOME SAFE HOME Identifying the security challenges of smart homes

Exploring a Data-Centric Approach to Securing Smart Homes

Dr. Lan Wang

As more homes become smart homes, new threats to security emerge. Dr. Wang's team is working to accurately identify vulnerabilities present in today's systems and the shortcomings of the current approach to smart home security. This research, according to Wang, will pave the way for the development of a new, more robust system.

"We will develop a prototype using Raspberry Pi® and Android® phones that will not only be more secure but also capable of collecting room temperature and adjusting it based on human presence and user preferences," Dr. Wang says. "If we are successful, our technology can be used to secure other types of smart environments, such as smart offices, smart factories, and smart warehouses."

○ SILVER LINING Improving the accessibility and security of the cloud

Cloud Computing Security and Privacy Assessment: A Scenario-Based Taxonomical Approach

Dr. Sajjan Shiva

As cloud computing grows, so does the need for better security and privacy. Unfortunately, there is a communication gap between cloud service providers (CSPs) and cloud users. Dr. Shiva is focused on developing new tools that can help users better understand their cloud options and help cloud service providers better protect cloud content and those who use it.

"We aim to fill the gap between consumers and CSPs by encouraging CSPs to have their services proactively and continuously evaluated for security and privacy features," Shiva says, "and then share the results with consumers, along with pricing." That transparency, according to Shiva, will drive competition among CSPs, enhance the security of the cloud, and give users more confidence in the cloud's ability to protect them and their data.

○ A CURE FOR ILL WILL How can malicious spam on healthcare websites be prevented?

Security Online - Healthcare Communities Against Malicious Users

Dr. Naveen Kumar, Dr. Deepak Venugopal

Malicious opinion spam messages on medical community websites can damage a healthcare provider's reputation and undermine the efficacy and value of web-based interaction between providers and their patients. In fact, more than 90% of users refer to online reviews before making a decision. Drs. Kumar and Venugopal are working to develop a practical approach of detecting and preventing these harmful messages.

"I envision a future," says Dr. Venugopal, "where machines can automatically learn to read content of the world's largest dictionary (the Internet), understand them deeply, validate them, and present them effectively to the user. I believe this is crucial because 'big data' is essentially worthless if one does not have effective, automated methods to make sense of the data."

Other CAST projects initiated in 2015-16 include:

Cognitive Neuroscience Perspectives on Protection Motivations and Security Behaviors in Information Security Contexts

Dr. Thomas Stafford, Dr. George Deitz

Investigating Characteristics of Cyberbullying in Higher Education

Dr. Mitsunori Misawa

Cyber Security Employment Pipelines: Successful Paths to Careers in Cyber Security

Dr. Judy Simon, Dr. Sandi Richardson, Ruby Booth

Criminology and Cyber Security Dimensions of Public Health in Urban Environments

Dr. Marian Levy, Dr. Debra Bartelli, Dr. K. B. Turner, Andy Kitsinger

Privacy Data Impact on Retail Consumers and Suppliers

Dr. George Deitz, Dr. Mehdi Amini



BEYOND THE SUPPLY CHAIN

Biologistics Research Cluster

The Biologistics Research Cluster collaborates with the Intermodal Freight Transportation Institute to research and develop better ways to safely transport and store high-value, temperature-sensitive, and time-critical biological materials, including tissue and blood samples, vaccines, and pharmaceuticals.

WHAT'S NEXT in biologistics.

The Biologistics Research Cluster's nine currently funded projects are exploring everything from using 3D-printing technology for pill manufacturing to engineering novel supercapacitor batteries that can be used in biologic applications.

○ PACKED WITH INNOVATION Discovering better ways to pack biologistic materials

Advanced Aerogel Packaging Solutions for Cold-Chain Biologics Materials Handling

Dr. Firouzeh Sabri, Dr. Jeffrey Marchetta

The cold shipping of biological materials requires new kinds of packing materials to make it feasible. Drs. Sabri and Marchetta are heading up a team that is designing, constructing, and testing cold-chain biologic

packaging made with aerogel, a synthetic, ultralight material with strong thermal insulating capabilities.

According to Dr. Sabri, current packaging options are "rather primitive" and not adequate to meet the demands of biologistics in the future.

"We envision an advanced form of packaging technology that will dramatically outperform current technology," Dr. Sabri says.

The new packaging will help spur new procedures and advancements in medicine that would be difficult or impossible without reliable cold transport and storage.



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RETHINKING RESEARCH

Improving biologic theory and practice

Assessment of Biologistics Research and Practices: Proposing a New Cutting-Edge Research Agenda

Dr. Mehdi Amini, Dr. Mihalis Golias

While demand for biologistics services is growing at a fast pace, its theory and practice are at their early stages of development. That's why Drs. Amini and Golias are engaged in an in-depth assessment of biologistics research in order to recognize and implement best practices and develop a cutting-edge research agenda.

According to Dr. Amini, the specialized nature of biologistics, compared with traditional logistics, introduces a new set of complexities and challenges for both academics and supply chain executives.

"Studying best practices in research, as well as in practical applications, will benefit the U of M research community and all interested researchers and practitioners of biologistics around the world," he says.

EASIER PILL TO SWALLOW

Exploring how 3D printing for pharmaceuticals could change medicine

Alternative Biologistics for Pharmaceutical Products: 3D-Printed Tablets and Pills

Dr. Ebrahim Asadi, Dr. Sabya Mishra

What if a pill could be made-to-order at the point of delivery? Drs. Asadi and Mishra are exploring the

technical viability and biologistics impact of using 3D-printing technology to manufacture tablets and pills in custom dosages, shapes, and dissolvability rates to match the needs of each patient.

According to Dr. Asadi, "This technology is in its early stages, but eventually, it has the potential to not only improve patient care but also reduce the need for mass-production facilities, as well as the costly transportation and storage of pharmaceuticals."

EARTH-SHAKING STUDY

Learning how natural disasters impact biologistics

Post-Disaster Management of Freight Transportation Networks

Dr. Charles Camp, Dr. Shahram Pezeshk, Dr. Chris Cramer

What impact will future earthquakes and other disasters likely have on transportation system infrastructure? Drs. Camp, Pezeshk, and Cramer are using FEMA's HAZUS-MH 2.2 software to study this question and, more specifically, assess how damage may affect temperature-controlled logistics services.

"The ability to plan and manage transportation after a major disaster, such as an earthquake or flooding," says Dr. Camp, "is critical not only to the long-term economic viability of our community but also to the post-disaster recovery of the region."

Other Biologistics projects initiated in 2015-16 include:

Biologistics of Lung Cancer Screening and Management Using Field Effect of Carcinogenesis and a Novel Biophotonics Technique

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Biologistics Security: Implications for Market Growth, Transportation, and Logistics

Dr. Haskel D. Harrison, Dan Pallme

Big Data Analytics Meets the Internet of Things: A Paradigm Shift in Biologistics

Dr. Mohammed Yeasin, Dr. Sabya Mishra

Smart Packaging Temperature Sensing for Biologistics

Dr. Firouzeh Sabri

Engineering Novel Supercapacitor: Batteries for Biologistics

Dr. Sanjay Mishra, Dr. Jingbiao Cui

BEYOND THE LAB: Engaging the Larger Community

Promoting Cluster-Community Interaction

Keeping the larger community informed of the work the clusters do helps keep ideas flowing, encourages engagement, and fosters understanding. In 2015–16, the Institute formalized a process for this interaction to take place, which includes:

Lightning Talks from the researchers to familiarize the members of the clusters and the Memphis community of their research focuses.

Monthly Meetings to bring the interdisciplinary cluster fellows together to discuss their progress and stay abreast of the latest trends in the cluster.

Progress Reports that provide evidence of research progress throughout the funding period.

Research Workshops that provide a forum for cluster fellows, the academic community, and corporate partners to come together to discuss the work of the clusters.

Community Engagement Events and Workshops that offer the Memphis community opportunities to interact with world-class researchers in emerging technologies and see how Memphis is staying at the forefront of innovation.

A TRADITION OF MEMPHIS INNOVATION
The FedEx Institute of Technology is proud to call Memphis home. Our city is no stranger to world-changing innovation. After all, it's the birthplace of Rock and Roll. It's where the self-service grocery store was invented, where the first modern hotel chain got its start, and where overnight delivery changed logistics forever. Today, this tradition of innovation continues at the University of Memphis, and the FedEx Institute of Technology is leading the way.

The UofM Graduate School

Given that graduate students are at the heart of the research enterprise, the UofM Graduate School relocated to the Institute during the 2015–16 year. It was a natural fit, as both the Institute and the Graduate School share the same strong commitment to research. As the Graduate School serves approximately 1,000 doctoral and 3,000 master's students in 118 graduate and research programs across campus, this move will speed up the research cycle across campus. It will also strengthen interdisciplinary collaboration. Master's degree programs are offered in 53 areas and the doctorate of philosophy degree is offered in 20 areas. Additionally, doctorates of audiology, education, and musical arts are offered, as well as an education specialist degree.

The Office of Technology Transfer

The Institute houses the Office of Technology Transfer, which works with Memphis faculty researchers to invest in and protect, through patents and copyrights, promising inventions and breakthroughs. The Office also licenses the intellectual property to local and national companies. At the end of our 2015–16 fiscal year, the Office's intellectual property portfolio had grown to include 147 invention disclosures, 25 issued U.S. patents, 6 copyrights, and 15 licenses to industry.

INVENTION DISCLOSURES

- **Bioelectrodynamics Modulation Method**
Marcy Purnell (UofM), Michael A. Whitt (UTHSC)
- **Tiger Town App**
Jeffrey Scott Kupper
- **Multilayer Additive Printed Electronic Circuit**
Bashir Morshed
- **Lightweight, Flexible Temperature Sensor Kit for Biologistics**
Firozeh Sabri, Steve Allison

ISSUED PATENTS

- Patent No. 9,297,693
Spatially-selective reflector structures, reflector disks, and systems and methods for use thereof
Orges Furxhi, Eddie L. Jacobs, Thomas Layton
- Patent No. 9,248,441
Polymer nanocapsules entrapping metal nanoparticles
Eugene Pinkhassik, Sergey Shamakov
- Patent No. 9,183,927
Memory devices, methods of storing and reading data, SMM junctions, and methods of preparing alumina substrates
Lam H. Yu
- Patent No. 9,158,841
Methods of evaluating semantic differences, methods of identifying related sets of items in semantic spaces, and systems and computer program products for implementing the same
Xiangen Hu, Zhiqiang Cai, Arthur C. Graesser, Scotty Craig

Emerging Technology Events

In 2015–16, the FedEx Institute hosted emerging technology events that drew more than 1,000 attendees from 50 local and national companies. These events included our Innovation In Action Series, designed to complement the work of our research clusters.

- Book Launch and Panel Discussion: *The Seventh Sense: Power, Fortune, and Survival in the Age of Networks* by Joshua Cooper Ramos
- Biologistics Research Project Luncheon for Industry

GoPro Film Festival

Lightning Talks for Biologistics, DRONES, and Cyber Security

Community Partners Kickoff

Autonomous Vehicles Roundtable

DRONES Community Kickoff

Memphis Biomaterials Day (student-organized event)

Drone Security Talk

3D Printing Community Workshop

Intellectual Property Lunch and Learn

Transforming Education With Virtual Reality

Unmanned Aerial Systems Demonstration

STEM Hub

Greater Memphis IT Council Conference

Commercial Drone Expo

Research Workshop on Advances and Innovations in Cyber Security

Drones Research Cluster Workshop

Data Science/Machine Learning

GenCyber Boot Camp 2016 - High School and Middle School

Technology Talk Featuring Kevin Kline

Game Development User Group

PASS User Group

Python Users Group

R Users Group

Ruby Users Group

WordPress Users Group

Corporate Training & Community Partnerships

The Institute is supported by a number of corporate entities and community partners. In turn, the Institute supported them in 2015–16 by hosting and co-developing dozens of meetings and training events. Partners include FedEx, Methodist Le Bonheur Healthcare, AutoZone, Tech901, and Memphis Technology Foundation.

Exclusive corporate training in 2015–16 included a 15-week Quality Driven Management training program for FedEx and a number of other high-profile events, including:

- Fundamentals of Cyber Security Certification Training
- STEP UP: 2-Day Continuing Systems Testing Excellence Program
- Foundational 5-Day Systems Testing Excellence Program
- Additive Manufacturing for Industry
- TBR Virtual Reality in Education
- Virtual Reality Workshop (FedEx Express TechOps Training, FedEx TechConnect, FedEx Brand Marketing)
- Additive Manufacturing Workshop (FedEx Express, FedEx Services, FedEx TechConnect, FedEx Freight)
- Unmanned Aerial Systems Demonstration (FedEx Freight, FedEx Express, FedEx)
- STEM Hub
- Greater Memphis IT Council Conference
- Commercial Drone Expo
- Research Workshop on Advances and Innovations in Cyber Security
- Drones Research Cluster Workshop
- Data Science/Machine Learning
- GenCyber Boot Camp 2016 - High School and Middle School
- Technology Talk Featuring Kevin Kline
- Game Development User Group
- PASS User Group
- Python Users Group
- R Users Group
- Ruby Users Group
- WordPress Users Group

Public Training

A prosperous future for Memphis depends on the development of technological skills that attract new business. That's why the FedEx Institute of Technology hosts public training workshops in a wide variety of disciplines. Training in 2015–16 included:

- Introduction to 3D Printing and CAD Design
- 3D Printing Workshop (FedEx TechConnect and FedEx Services)
- Beginner Python
- Introductory Web Design
- Basic Soldering
- Harvesting Web Content Data
- Drone Security Workshop
- Security Awareness FEMA Training by TEEEX
- International Conference on Design of Experiments
- Unmanned Systems Commercial Flight Rules Workshop
- Alternative Fuel Vehicle Conference

Student Training

One of the mainstays of our mission is providing students with critical training opportunities that can lead directly to jobs in the new economy. Over the past year, we partnered with Tech901 and Memphis Technology Foundation to offer training, with free admission whenever possible, to Memphis-area high school students and college undergraduates. Events included the Computer Science Capstone projects exhibition, instruction in computing foundations, and skills building through CompTIA A+ networking and security instruction.



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Drones, ROBOTICS AND NAVIGATION-ENABLED SYSTEMS (DRONES)

The DRONES research cluster has been established to provide proactive leadership in the fast-emerging field of unmanned systems, including autonomous vehicles, robots, and drones. Its goal is to bring new, practical applications of these technologies to commercial markets.

WHAT'S NEXT in unmanned systems.

Over the past year, the DRONES cluster has secured Institute funding for 11 research projects. The researchers are focusing on how drones can improve the bargaining process for farmers, how driverless vehicles will impact transportation planning, and much more.

○ H2OH! Using drones for water sampling in dangerous conditions

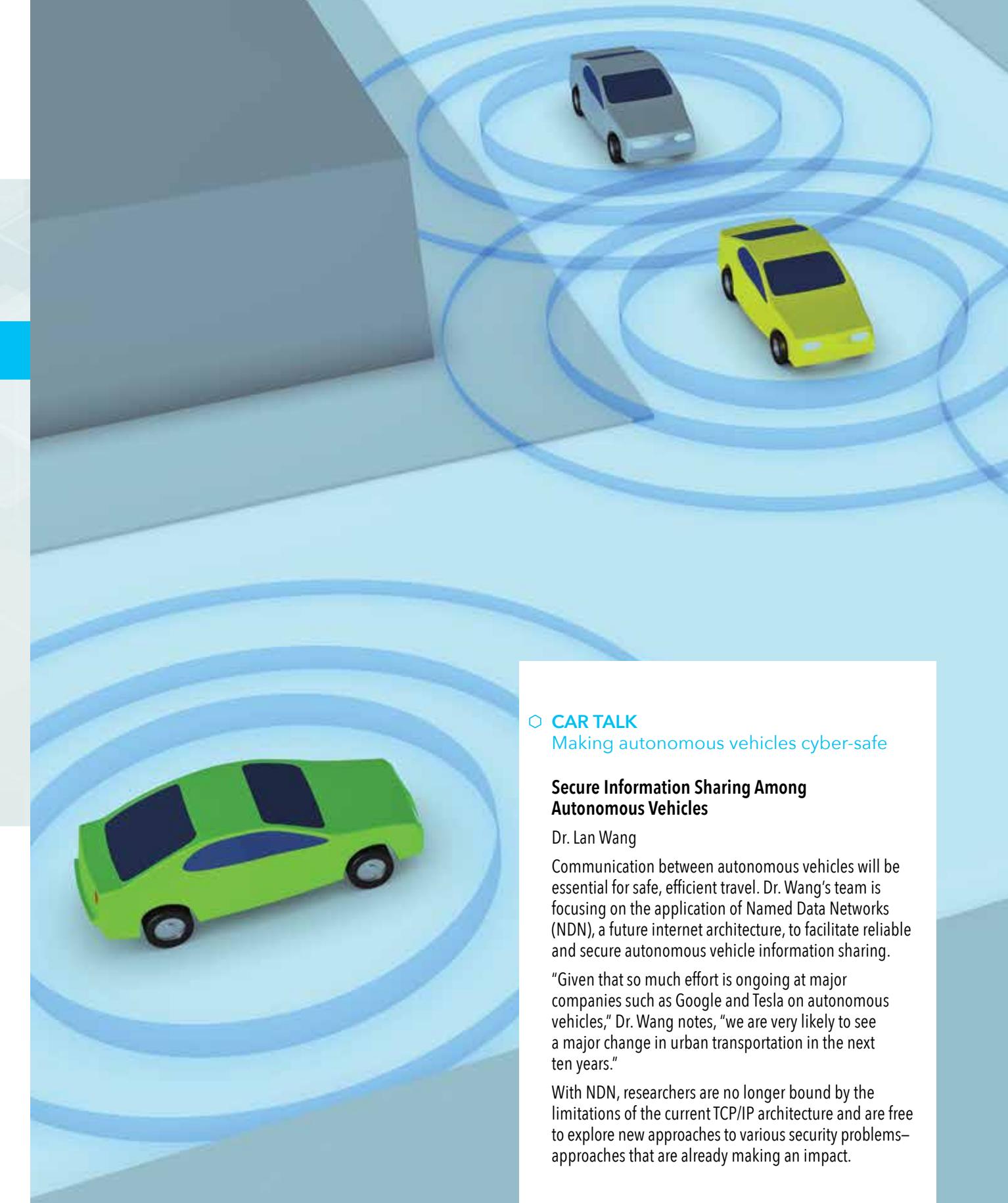
Application of Amphibious Drone Technology to Enable Environmental Monitoring and Sampling to Support Disaster Response and Drinking Water Resource Protection

Dr. William Alexander

Environmental monitoring, water source protection, and disaster management frequently require chemists to access dangerous sites. With funding from the National Science Foundation, as well as the Institute, Dr. Alexander is researching how unmanned amphibious systems can be used to ensure safer research and more secure testing procedures.

Inspired by the Elk River chemical spill of 2014 in his home state of West Virginia, which left over 300,000 residents without safe water for days and, in some cases, weeks, Dr. Alexander is working to not only keep disaster responders out of harm's way but also to directly improve public health, help responders mount a proper response, and to dispel public fear.

"We'll have the ability to collect and analyze water quality data in real time at the source and also make rapid and accurate quantum chemical predictions about the extent and movement of the contamination," he says. According to his studies, it takes an average of 6.5 days for robotics to be deployed in a disaster. "One of the things we are thinking about is how to decrease this response time using advanced logistical support."



○ CAR TALK Making autonomous vehicles cyber-safe

Secure Information Sharing Among Autonomous Vehicles

Dr. Lan Wang

Communication between autonomous vehicles will be essential for safe, efficient travel. Dr. Wang's team is focusing on the application of Named Data Networks (NDN), a future internet architecture, to facilitate reliable and secure autonomous vehicle information sharing.

"Given that so much effort is ongoing at major companies such as Google and Tesla on autonomous vehicles," Dr. Wang notes, "we are very likely to see a major change in urban transportation in the next ten years."

With NDN, researchers are no longer bound by the limitations of the current TCP/IP architecture and are free to explore new approaches to various security problems—approaches that are already making an impact.

○ ALL THE RIGHT MOVES

Improving decision-making in autonomous vehicle operation

Integrated Platforms and Algorithms of Multisensory Data Capture and Decision Support for Autonomous Vehicles

Dr. Robert Kozma

Successful operation of autonomous vehicles in dynamically changing, complex environments depends upon efficient multisensory data capture and decision support. Dr. Kozma is studying how the living brain captures multisensory data and makes decisions in order to develop algorithmic formulations that can be applied to the engineering of autonomous vehicle control. The goal is to equip vehicles with the fundamental properties of cognition.

"In our project," he says, "we integrate sensory information from multiple robotic platforms and provide the basis for decision-making, reconfiguration, and control. The integrated sensory robot system cumulatively creates and learns knowledge and integrates it to an internal model to guide its actions."

Equipping autonomous vehicles with a more robust decision support system will help them successfully navigate in rapidly changing scenarios and unpredicted conditions, enhancing emergency

response to natural disasters and ensuring a quicker response to cyber security threats.

"The novel contributions of this research are manifested in the way the robot, with its multisensory capabilities, makes the decision and action selection," Dr. Kozma says.

○ DRIVING CHANGE

How could autonomous vehicles change Memphis transportation?

Considering the Potential Impact of Autonomous Vehicles on Transportation Planning and Equity in Memphis

Dr. Charles Santo

While cities like New York and San Francisco look to emerging transportation technology to solve problems of traffic and congestion, cities like Memphis are too sprawling and too large geographically to have the population density needed to support efficient fixed-route transit.

Dr. Santo is heading up research into how demand-responsive shared autonomous vehicles such as driverless shuttles might allow for more efficient service in low-density or low-income areas.

"This technology may someday give affordable, reliable transportation to those in Memphis who do not have access to personal automobiles," Santo says.

Other DRONES projects initiated in 2015–16 include:

Deep Learning Enabled Non-Invasive Cognitive Interface: Where Machine Meets the Mind

Dr. Mohammed Yeasin

Enhancing Human Capabilities Using Unmanned Systems and Drones

Dr. John Hochstein, Dr. Robert Pap

Restoring Damaged Metallic Parts of Robots, Autonomous Vehicles, and Drones by Additive Manufacturing

Dr. Ebrahim Asadi

Investigating the Impact of Adopting Drones on the Bargaining Power of Farmers in a Contract Process

Dr. Ted Lee, Dr. Kevin Kim

Drone Journalism

Darrin Devault

Engineering Novel Lightweight Supercapacitor: Batteries for Ultra-Light-Vehicles

Dr. Sanjay Mishra

Legal Aspects of Drones

Dr. Larry Moore



BEYOND THE NUMBERS

The Big Data and Analytics Cluster

The Institute is pleased to announce the launch of a fourth cluster in 2015–16, Big Data and Analytics.

WHAT'S NEXT in data management.

In today's information-rich world, gaining a competitive advantage depends on being able to efficiently access, store, analyze, and apply massive amounts of data generated by customer relationship management systems, web applications, social media, and the Internet of Things. The cluster's initial projects are dedicated to exploring ways to help industry use big data and analytics to solve problems and create new opportunities.

BEYOND THE SMARTPHONE

Mobile Sensor Data to Knowledge (MD2K)

MD2K is one of 11 national Big Data Centers of Excellence awarded by the National Institutes of Health (NIH) as part of its Big Data-to-Knowledge initiative.

WHAT'S NEXT in wearable health sensors.

In 2015-16, the MD2K team continued its research and development of innovative tools that make it easier to gather, analyze, and interpret health data generated by mobile and wearable sensors. The goal is to reliably quantify physical, biological, behavioral, social, and environmental factors that contribute to health and disease risk.

MINING DATA

Getting more out of sensor data

Researchers from MD2K, in collaboration with researchers at the National Institute on Drug Abuse (NIDA) Intramural Research Program, are working on better ways to translate data from wearable sensors into useful information that can help people monitor and improve their health. One of the ways to do that is by providing a just-in-time intervention, such as a text message or prompt, that is issued based on sensor data collected in real time.

The team is especially interested in using sensor data to measure and track stress in wearers and creating new opportunities for future research to design interventions for dealing with daily stress in both work and personal lives.

SMOKE SIGNALS

Using a new approach to help people quit smoking

What if a newly abstinent smoker could wear a sensor that would detect when he or she has that first puff? What if it was possible to intervene before that puff turned into a full relapse into smoking?

Recent research demonstrated the feasibility of detecting smoking from wearable sensors, but performance in real-life situations was unknown. So, the MD2K team conducted a trial of a new computational model they developed call puffMarker to see how accurate it was in detecting smoking by newly abstinent smokers. Wearable sensors were used to track arm movements and breathing patterns.

The puffMarker model proved to be highly accurate in correctly pinpointing the timing of the first smoking lapse in participants with only occasional false episodes detected. As a result, the puffMarker model is being incorporated into MD2K mobile phone software for real-time detection of smoking lapses.

BEYOND NATURAL INTELLIGENCE

Institute for Intelligent Systems

The IIS is dedicated to advancing the state of knowledge and capabilities of intelligent systems, including psychological, biological, and artificial systems. It is using an interdisciplinary approach that brings together researchers from many different research areas in the cognitive sciences, including biology, communication sciences & disorders, computer science, education, engineering, linguistics, philosophy, physics, and psychology.

WHAT'S NEXT in intelligent systems.

Over the past year, IIS continued its work developing technologies in the cutting-edge areas of cognitive science, artificial intelligence, complex dynamic systems, neural networks, evolutionary modeling, massively parallel systems, and biological systems. Its work is divided into three areas: learning, language, and artificial intelligence.

FACE TIME

Creating a computer tutor that can read your expressions

Using computers to help us learn is nothing new. But the researchers at IIS are taking it to a whole new level with AutoTutor, a computer tutor that can hold a conversation in natural language and track the cognition and emotions of the student. AutoTutor recognizes emotions through dialogue patterns, facial expressions and body posture, and then adapts to respond accordingly. This exciting technology is currently helping students learn about physics and computer literacy.

A WAY WITH WORDS

Developing web-based technologies to analyze texts

How effective is the written word? There are many ways to evaluate language and discourse, and a web-based computer facility called Coh-Metrix knows them all. IIS has developed Coh-Metrix to analyze texts for word concreteness, syntax, cohesion, and storyhood. That gives the user greater insight into the properties, character, and effectiveness of text. In fact, Coh-Metrix is being used to analyze texts in the Common Core standards for reading and literacy and is being used by thousands of individuals to analyze texts of every description all over the world.

OTHER FUNDED PROJECTS

Other exciting projects funded by the Institute over the past year include:

Improving Circadian Rhythm Amplitude

Dr. Andrew Liu

The cell is the fundamental unit for generating our "internal clock." The goal of Dr. Liu's study is to probe protein function with precise biochemical detail and ask how the clock proteins work together in cells to keep the long, recurring 24-hour time and to regulate rhythm amplitude and period length. An invention disclosure and a patent application related to this research have been filed in partnership with the University of Pennsylvania School of Medicine.

ATX Inhibitors – Diversification Into New Chemical Entities

Dr. Abby Parill-Baker

Dr. Parill-Baker is collaborating with a drug discovery researcher at St. Jude Children's Research Hospital to develop a novel and useful new cancer compound. In the study, thirty-three compounds are being synthesized and assayed using a three-tiered assay scheme. The project has already resulted in an issued patent.

Online Analyzers for Trihalomethanes and Haloacetic Acids

Dr. Gary Emmert and Dr. Paul Simone

The first part of this study was dedicated to the development of a fully automated prototype instrument capable of simultaneous individual THMs and HAAs analysis. The second part was the pursuit

of U.S. Environmental Protection Agency certification. This technology is related to four issued patents, one license, and a startup company.

Chitosan Barrier Membranes for Guided Bone Regeneration

and

Dual-Action Biomaterial Coatings to Prevent Implant Infection

Dr. Joel Bumgardner

Both of these projects are focused on bone grafting/infection control associated with repair of orthopedic and dental/craniofacial bone defects and implants. These projects have resulted in two invention disclosures, and a patent application has been filed. Additionally, two very large dental companies have started talking to Dr. Bumgardner about the technology, and a third has made brief inquiries.

Hybrid Nanoparticles & Microfluidic Devices

Dr. Xiaohua Huang

As a collaborative research effort among chemistry, physics, and electrical engineering departments, as well as the UT Health Science Center, this project is focused on developing a new device and technique for finding circulating tumor cells based on the fact that tumors are not deadly until they spread, which occurs when cells break off from the original tumor and move to other organs via the blood circulation. A patent application related to this research is pending.

RESEARCH CENTERS

In addition to the Research Innovation Clusters, the Institute supported several other research centers in 2015-16, including:

- Center for Translational Informatics
- Systems Testing Excellence Program
- SENSORIUM
- Center for Smart Biomaterials
- Center for Technologies and Research in Alzheimer's Care
- Center for Information Assurance
- Center for Applied Earth Science and Engineering Research (CAESER)

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