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IMPACT

The Research Newsletter of Stevens Institute of Technology Summer 2014

Wireless Wonder

Stevens researcher Dr. Yingying Chen builds the smartphone applications and wireless networks of the future

Dr. Yingying Chen looks at smartphones and sees more than communication and email devices. She also sees vast potential to transform both the ways we monitor our health and the safety of the nation's highways.

Chen, an associate professor of electrical and computer engineering and director of Stevens' Data Analysis and Information Security (DAISY) lab, recently secured a grant from the National Science Foundation that could transform the way we monitor health — particularly for the elderly, children, people with autism and others who may be less likely to report new health issues to family and doctors.

She came to the task with plenty of mobile-technology experience: Chen has also developed an eye-opening new technology application that senses which mobile device belongs to the driver of an automobile. This technology could potentially be incorporated into safety features to block some of a driver's distracting mobile phone capabilities while preserving the freedom for passengers to continue fully using their devices.

Automobile manufacturers and insurance companies are interested.

To tackle the healthcare problem, Chen began by polling doctors and colleagues in medical technology, who explained that current healthcare apps don't yet function especially well for a basic reason: many users, including the elderly and children, are unable to enter personal data regularly or reliably. Others are capable but neglect to do so.

"Many of us don't have time, or simply forget, to type in records of our meals, exercise, medications and so on," explains Chen. "Others are intimidated by smartphones. I knew something simpler and more automated needed to be created."

Working with a graduate student team and with support from the National Science Foundation, Chen developed a new method of utilizing smartphones' multiple sensors — which include motion sensors and gyroscopes, in addition to the phones' built-in cameras and microphones — in concert with easy-to-wear wristbands that passively monitor heart rate, activity and body temperature.

Dr. Yingying Chen's detection system sends a series of customized, high-frequency beeps through an automobile's audio system to the speakers via smartphone, then uses acoustic ranging technology to determine which device belongs to the driver. The system is 90 to 95 percent accurate.

The system her team is developing, SENSCOPS (smartphone-enabled social and physical compass system), reports the patient's vitals wirelessly to central servers at regular intervals via a simple mobile app.

The implications are enormous: software on the server side could be built by the healthcare industry to analyze this data and send regular updates to medical professionals, collecting and confirming routine medical information (vital signs, emotional and physiological response to medications, activity patterns) while also flagging potential emergencies in the making.

A report from the app of a lack of patient motion for an unusually long period of time, for example, might signal SENSCOPS to automatically text-message a nurse, who could call or visit the patient immediately to learn more.

continued inside

INSIDE HIGHLIGHTS:

Stevens Computer Scientist Kleinberg Receives NSF, NIH Awards

Kleinberg's approach uses prior knowledge to help generate hypotheses from the data and determine which are novel and merit further validation.

Stevens researcher and computer science professor Dr. Samantha Kleinberg has received a 2014 National Science Foundation Early Career Development (CAREER) Award, one of three Stevens computer science faculty members to recently be acknowledged by NSF. It is Kleinberg's second major research award in the span of less than one year.

The NSF proposal, "Learning from Observational Data with Knowledge," involves integrating prior knowledge with large-scale data to enable efficient inferences. With the proliferation of new methods for gathering long-term population data (from electronic medical records) and real-world health data (from body-worn sensors), researchers now have access to highly detailed time series data. Kleinberg's work in particular aims to understand the processes underlying recovery in stroke patients from ICU data and factors affecting blood glucose using sensor data from diabetes patients.

Instead of relying upon controlled experiments (which can be expensive and time-consuming) to test a small set of highly targeted hypotheses, it is becoming increasingly possible to use data itself to construct hypotheses. One of the challenges of large observational datasets from domains such as biomedical informatics and social networks is that while they enable researchers to test complex hypotheses, they also lead to an enormous search space and burden researchers with the task of determining which hypotheses may be interesting.

Kleinberg's approach uses prior knowledge to help generate hypotheses from the data and determine which are novel and merit further validation. Her work focuses specifically on inferring causal relationships, which give insight into not just what is happening but why it is happening and could ultimately lead to targets for future interventions. This work will lead to more robust and efficient inference from large-scale datasets through a feedback loop between experiments and prior knowledge. The approach Kleinberg develops will improve computational efficiency while also enabling discovery of novel relationships.

One year earlier, in May 2013, Kleinberg received a National Institutes of Health (NIH) R01 research grant award in collaboration with Stevens computer science professor Adriana Compagnoni and Columbia University neurology professor Jan Claassen to more efficiently analyze unwieldy time-series datasets. The project, "Causal Inference in Large-Scale Time Series with Rare and Latent Events," also has broad implications for healthcare, including for neurological intensive care units (NICU), where large volumes of data generated from continuous recording of patients' brain activity and physiological signs can overwhelm clinicians' ability to detect complex patterns in real time.

For patients recovering from a stroke in a NICU, a seizure is a rare event — but one that can have a significant impact on their outcomes. Kleinberg and her collaborators are developing systems and algorithms to give clinicians information quickly enough to have an impact on patient care.

"Doctors need to know not just that an ICU patient being treated for a stroke is having a seizure, but whether it is causing further injury before they can determine how to treat it," explains Kleinberg, who will serve as principal investigator on the project. "We want to develop a way to give more timely and robust alerts so that doctors can quickly formulate a course of action."

The NIH award, for $654,854, will support research through 2016.

WIRELESS WONDER continued from cover

If the system proves viable in the field, the SENSCOPS could be ready for collaboration with medical or insurance industry in as little as a year or two, she adds.

Securing communications in battle and crisis situations

The star researcher works on a number of personal and national security issues, as well. In one paper, Chen and two collaborators proposed a mobile wireless network of sensors and algorithms to perform continuous surveillance for security threats such as radiation, bioterrorist threats or pollution. In another project, supported by the National Science Foundation (NSF), she proposed more secure, better-encrypted information-sharing methods between mobile devices.

More recently Chen has worked to create more secure wireless networks for battlefields, natural disasters and other crisis situations where communications hardware may be inaccessible, insecure or otherwise compromised by conditions. With support from an Army Research Office (ARO) grant, her team is devising new methods of authentication that can generate private keys instantly based on unique physical properties of each specific device such as wireless signal strength or channel state.

"Wireless communication has played a crucial role in supporting numerous military and civilian applications," Chen points out. "But one serious concern facing the successful deployment and adoption of these emerging applications, especially mission-critical tactical tasks in hostile battlefield environments, is the need to assure secure and reliable data delivery to enable proper response to scenarios that threaten the availability of wireless communications."

Members of law enforcement or emergency response organizations could use the same technology to communicate securely even when outside the bounds of their normal technical infrastructures.

"Over-the-air communication has played a crucial role in supporting numerous military and civilian applications," says Michael Bruno, dean of the Charles V. Schaefer, Jr. School of Engineering and Science at Stevens. "Technologies that can guarantee the security of wireless transmissions in remote surroundings would go a long way toward ensuring the effectiveness of military missions and the safety of the servicemen and women who carry them out."

Dr. Chen's ARO support continues through 2016.

MESSAGE FROM THE VICE PROVOST OF RESEARCH

Welcome to IMPACT

I would like to welcome the Stevens community, as well as our friends and collaborators at fellow institutions, to the inaugural publication of **IMPACT.** This newsletter will be issued as a quarterly collection of articles, meant to showcase the remarkable diversity and breadth of research and scholarship at Stevens.

Guided by the Stevens strategic plan, "The Future. Ours to Create.," we at the Office of the Vice Provost of Research have embarked upon a journey of unprecedented growth. Over the past several years, our research expenditures from public and private sponsors have totaled approximately $30 million annually. We are engaged in a variety of projects in the areas highlighted in our strategic plan. These include, but are not limited to, areas such as:

- **Healthcare and Medicine**
- **Sustainable Energy**
- **Financial Systems**
- **Defense and Security**
- **STEM Education**

With more opportunities than ever before, I am confident we will continue to significantly enhance our research portfolio by leveraging our most effective assets.

These range from respected Stevens institutions such as the Systems Engineering Research Center (SERC), one of our national Centers of Excellence funded by the Department of Defense as a University Affiliated Research Center (UARC), to bright young faculty such as Dr. Samantha Kleinberg, who has the distinction of having received both an NIH R01 award and an NSF CAREER Award within the span of just one year.

Together we are significantly expanding our research to **impact** our state, our region, our nation and the world. I am excited to introduce **IMPACT** to keep our friends and colleagues abreast of our leading-edge research projects, share the challenges of the future and, perhaps most importantly, share our successes for the greater good.

I invite you to enjoy the rest of **IMPACT**. I hope you'll welcome its publication and send us your feedback to impact@stevens.edu.

Mo Dehghani, Ph.D.
Vice Provost of Research
Stevens Institute of Technology

Stevens-led SERC's DoD Contract Renewed, New Research Initiated

The Systems Engineering Research Center (SERC), a University Affiliated Research Center (UARC) led by Stevens Institute of Technology, received a $60 million, five-year renewal contract from the U.S. Department of Defense (DoD) in Fall of 2013.

"This significant contract demonstrates the SERC's critical role in helping the DoD maintain and advance critical engineering and technology capabilities through systems engineering research."

SERC, a consortium of twenty-plus universities, will utilize the support to continue producing and supporting important insights into how to affordably create and evolve complex systems and educate the next generation of systems engineers, weaving systems thinking and systems engineering into senior design projects such as a 'spike strip' that can thwart pirate boats in the sea and a torpedo-like device for similar purposes.

SERC also supports research into secure flight-control systems, workforce development for systems engineering disciplines, and the development of new technical tools including more flexible and trusted systems; advanced models for risk assessment; and refined tools for carrying out tradespace operations.

"This significant contract demonstrates the SERC's critical role in helping the DoD maintain and advance critical engineering and technology capabilities through systems engineering research," said Dr. Dinesh Verma, executive director of SERC and dean of the School of Systems and Enterprises (SSE) at Stevens.

Among the research being produced is intriguing work by the Helix Project, a multi-year investigation of the 'DNA' of systems engineers. Sponsored by DoD and the National Defense Industrial Association Systems Engineering Division (NDIA-SED), with active engagement from the International Council on Systems Engineering (INCOSE), the project aims to answer important questions about the systems engineering workforce, particularly in the defense industry.

Early findings from the Helix Project, which began in late 2012 and will run for several more years, include identifying the most important characteristics of strong systems engineers (such as the ability to simultaneously manage both the broad picture of a system and many of its technical details), typical career paths for chief systems engineers, and ways in which mentoring can help develop young systems engineers.

To learn more, visit **stevens.edu/SERC.**

New Center Places Stevens at the

Healthcare is one of the most important sectors of the U.S. economy, constituting one-fifth of the U.S. gross domestic product (GDP) and supplying one out of every five jobs created. But the sector also brings myriad financial, policy, technical, scientific and management challenges.

Stevens has accepted this challenge. In 2013, the university unveiled the Center for Healthcare Innovation (CHI), a research and educational center drawing on more than 60 faculty across multiple disciplines to serve as a focal point for the university's healthcare research and academic programming. Its primary functions include drug discovery, tissue engineering and healthcare logistics research and education.

The Center performs and supports diverse interdisciplinary research on medical devices, sensors, biomaterials, drug discovery, data mining, medical imaging and other key areas in partnership with leading hospitals and medical schools such as Georgetown University and Hackensack University Medical Center.

Biopsy samples grown in three-dimensional microfluidic cultures — a technology developed at Stevens with its collaborators — could soon be used to assess the potential effectiveness and side effects of cancer therapies before administering them.

CHI also deploys up to 30 scholarships annually to help attract and retain talented students, training new generations of future physicians, pharmaceutical researchers, information technologists and healthcare professionals.

The Biotechnology and Drug Discovery Laboratory, launched early in 2014, is a particularly important new initiative.

Intelligent Logistics Research to Power NYC Urban Preparedness

Stevens helps New York City prepare for and cope with future potential disasters and health emergencies

Disasters cannot always be predicted, as the tragedies of September 11 and the terrible force of Superstorm Sandy attest.

But they can be prepared for, and New York City has reached out to Stevens Institute of Technology to help ensure that response to future potential disasters and health incidents in the city — with its population of more than 8 million, spread across 300 square miles and five boroughs — will become safer, more seamless and more effective.

The city's Department of Health and Mental Hygiene (DOHMH) recently contracted with the School of Systems and Enterprises (SSE) at Stevens to develop intelligent logistics systems to speed distribution of life-saving medical resources in response to a potential bioterrorist attack or disease outbreak.

"A city's ability to respond to deadly emergencies is based on the efficiency and functioning of its critical systems," says Dr. Jose Ramirez-Marquez, an associate professor at Stevens and lead researcher on the project.

DOHMH has asked SSE to develop advanced modeling and simulation algorithms that optimally allocate staffing resources in a potential disaster, with the intent to bring more data and science to the city's public health emergency response planning.

"Public health emergency response systems are logistically extremely complex," explains Dr. Ramirez-Marquez. "Determining throughput capacity, staffing requirements, transportation necessities and site layouts to maximize resources are some of the intricacies that need to be addressed while building a recovery system.

"The goal is to bring the rigor of scientific research to New York City's complex public emergency system, and then build systems that will be intelligent, efficient and resilient, advancing the city's capability to prepare, respond and recover from disasters."

In addition to a module that will optimize staffing resources during emergencies, SSE will also create tools to model and optimize the distribution of medicines and medical supplies across the city's disaster-recovery facilities, Ramirez-Marquez added.

Heart of Healthcare Research

Established in part through a generous donation in kind from Roche, the lab includes a group of 11 pharmaceutical industry personnel with expertise in biotech and drug discovery as faculty and researchers who hunt for new therapeutic drugs and other innovations.

"Serving as a center for research in the areas of preclinical gene cloning and purification of therapeutic proteins, assay development as well as computational and robotic drug screening, this laboratory also provides industry collaborators with a local academic partner for research and workforce training," says Dr. Peter Tolias, director of CHI. "It positions Stevens as a premier research university and industry partner for biotechnology and drug discovery."

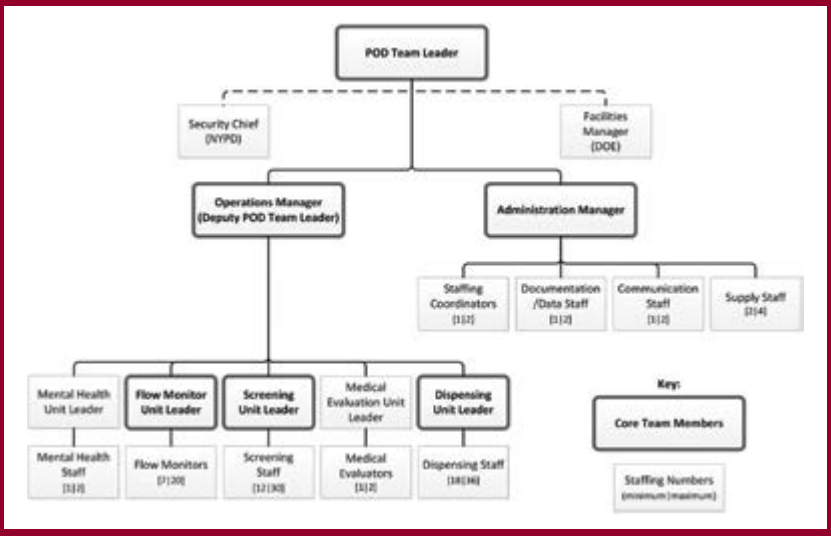
Stevens and CHI are also sponsoring research initiatives in the tissue engineering of cancer biopsy samples. Particularly with regard to cancer, technical advances and research may soon enable far more efficient treatment through 'personalized' medicine. Biopsy samples grown in three-dimensional microfluidic cultures — a technology developed at Stevens with its collaborators — could soon be used to assess the potential effectiveness and side effects of cancer therapies before administering them.

CENTER FOR HEALTHCARE INNOVATION

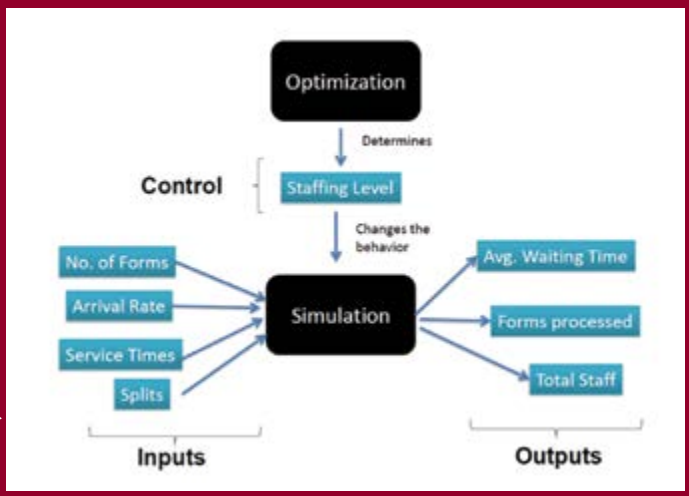
"We can use this technology to examine the genetics of a given patient's cancer, select appropriate therapy and examine the response to the selected drugs in these cultures first, in order to determine whether they will work in the patients. This will assist the physician in selecting a treatment based on that patient's personalized biopsy," explains Tolias.

In addition to medical research, CHI also coordinates complex healthcare research in a number of related areas including medical computer systems, medical records collection and analysis, clinical literature, hospital management of patient flow, operating room ergonomics and cost-benefit analyses of medical procedures.

To learn more, visit **stevens.edu/CHI.**



New York City's points of dispensing (POD) staffing plan, consisting of six pre-trained core team members and up to 100 staff members trained upon reporting for emergency duty. The POD network consists of 175 city sites for emergency medication distribution, with locations chosen based on population density.



Factors involved during the building and modeling of emergency scenarios, including integration of discrete event simulation with multi-objective optimization.

ABOUT STEVENS

Stevens Institute of Technology, *The Innovation University*®, is a premier, private research university in Hoboken, N.J. Within the university's four schools, more than 6,100 undergraduate and graduate students collaborate with more than 350 faculty members to advance the frontiers of science and leverage technology to confront global challenges. Stevens is home to three national research centers of excellence, as well as joint research programs focused on critical industries such as healthcare, energy, finance, defense, STEM education and coastal sustainability. The university is consistently ranked among the nation's elite for return on investment for students, career services programs and mid-career salaries of alumni.

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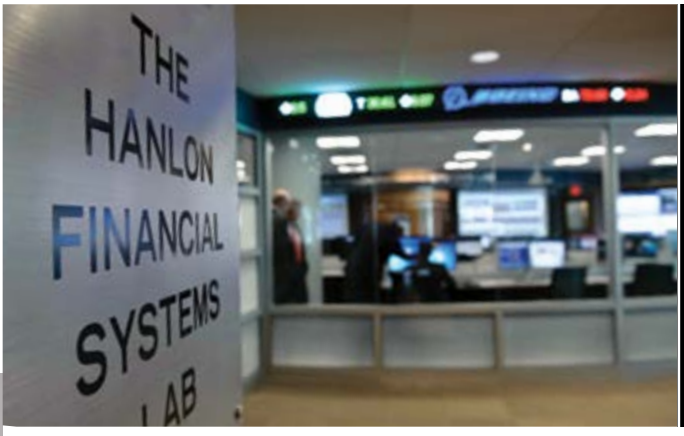

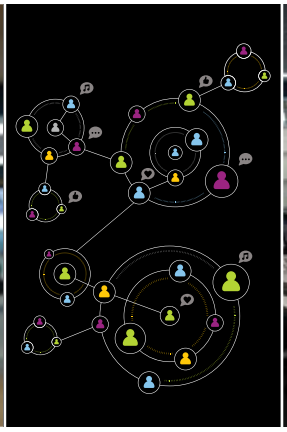

Do Social Networks Tip the Market's Hand?

Stevens financial researcher examines corporate connections

Stevens professor of quantitative finance and business analytics Dr. Germán Creamer works at the intersection of social networks and finance — and what he has learned is striking. Creamer's pathbreaking research demonstrates that link mining, relationship mining and news and sentiment analysis can be used to help anticipate and predict earnings surprises and other asset price moves.

Creamer, who authored the original proposal that eventually led to the establishment of Stevens' leading-edge Hanlon Financial Systems Lab, created a model of relationships between directors of publicly traded S&P 500 companies and the analysts who provide coverage on those companies. Tapping into the resources of the Hanlon Lab, Creamer then used algorithms to determine whether analysts' surprise predictions for companies with whose leadership they were socially 'close' were more likely to be accurate.

They were. Earnings surprise forecasts correlated much more strongly to actual surprises when analysts were socially close to directors. Interestingly, Creamer found this effect diminished somewhat after 2001, when the federal Regulation Fair Disclosure brought far greater transparency to company financial information and effectively ended the process of selective corporate disclosure of operations to small groups of analysts.

Calling Creamer's technique a 'different angle,' Deutsche Bank's influential newsletter *Market Research* singled out the Stevens research for special interest.

"This approach could help to disentangle the conflicts of interests between company management, investors and analysts, and hence provide better forecasts for earnings surprises and abnormal returns," noted the newsletter's authors.

"This approach could help to disentangle the conflicts of interests between company management, investors and analysts, and hence provide better forecasts for earnings surprises and abnormal returns."

Working with a team from Columbia University, Creamer also is creating algorithms that parse published news and predict the future directions of U.S. stocks.

"The correlation is between 10 percent and 30 percent," Creamer explains. "Again, it is another signal, not strong to use alone but something that adds to your equities research and refines it."

To learn more about Stevens financial and management research, visit **stevens.edu/howe.**