HAO CHEN is watching our backs. Actually, he’s watching our fingers. After a fashion.

Chen, an associate professor in the UC Davis Department of Computer Science, has embraced the fascinating task of anticipating how hackers might steal our personal data — before they think of such methods. His field of study — computer security — requires creativity, an ingenious use of psychology and the ability to think outside the box. Particularly the latter.

“Thinking outside the box is a critical skill of security researchers,” Chen explains. “It’s how hackers often exploit computer systems; they use them in ways that aren’t intended. In order to stay ahead of hackers, we need to do the same.”

Chen’s arrival at UC Davis in 2004 coincided with a technological leap in personal computer use, and the rapid adoption of mobile platforms. “The 3G network began to get popular, and smartphones started to arrive,” says Chen, who earned his Ph.D. from UC Berkeley. “More people began moving to mobile-based computing, so we examined the new security problems regarding cellular networks.”

During a collaborative research project with Sprint, Chen and one of his students, Lian Cai, became captivated by some of the company’s newest mobile smartphones. (This was shortly before the introduction of Apple’s iPhone.) “We wondered what new vulnerabilities they might have. We realized that — compared to desktop and laptop computers — smartphones are equipped with many sensors. So we wondered: If hackers got access to sensor data, what could they do?”

“Then the iPhones and Androids came out, with lots of new sensors, one being the accelerometer.”

Continued on page 12
INNOVATIVE SOLUTIONS:
RICARDO CASTRO TACKLES MATERIAL BEHAVIOR CHALLENGES AT THE NANO LEVEL TO IMPROVE STRUCTURAL RESISTANCE AND SENSITIVITY

By Derrick Bang

UPON JOINING UC DAVIS in 2009, Professor Ricardo Castro immediately plunged into two distinct but related projects. The first, the development of nanocrystalline materials for radiation resistance, caught the attention of the U.S. Department of Energy’s Office of Science, which awarded Castro an Early Career Research Program Award in spring 2011, including a grant of $762,935.

Castro’s second project, involving an effort to control the behavior of nanoparticles under heat treatment, resulted in a National Science Foundation CAREER Award, also in spring 2011. This honor included a cash grant of $450,000. Both cash awards are intended to fund Castro’s respective projects over five years.

Castro’s goal with the first project is the design and development of radiation-resistant materials for structures — such as nuclear power plants — that must withstand extreme environments. The steel often used for such structures quickly starts to suffer from amorphization and loses its crystallinity (the degree of structural order in a solid); the metal becomes brittle and subject to breakage, and therefore must be repaired or replaced every few years. This is both expensive and time-consuming.

Castro is tackling this problem at the nano level. “Nanomaterials aren’t just different because they’re small; they have different properties because they are small.”

Very small particles are collectively surrounded by a lot of surface interfaces. Consider a cylinder filled with tennis balls; now imagine that same cylinder filled with small marbles. The marbles collectively possess far greater surface area and interfaces.

“The interface offers a space for the defect to occur without compromising the crystallinity of the structure,” Castro explains. “We’re working on sustaining the process, and using it to make better materials. The idea is to create safety supports for the steel used in nuclear...”
Castro, the recipient of a 2011 Young Investigator Award from the Society of Hispanic Professional Engineers (SHPE), is energized by his proximity to the many other researchers across the UC Davis campus. “It’s a highly scientific environment. I can go next door and talk high-level science to any of my colleagues, and get very good feedback. This makes my work better.”

While working on his Ph.D. at Brazil’s University of Sao Paulo, Castro took advantage of a program that allowed him to further his research during a half-year stay in a foreign country. He selected the United States and came to UC Davis, which he deemed a good place for his research into the phase transitions of nanocrystalline aluminum: how to better understand — and control — the phase change from alpha aluminum, used for its structural properties, and gamma aluminum, which is essentially a catalyst.

After earning his doctorate, Castro became a professor at Brazil’s Centro Universitário da FEI. He put together a lab and, after a few years, began a three-way collaboration with researchers at UC Davis and the Universidad Nacional Autónoma de Mexico (UNAM), on the subject of nano-structure materials, and how best to understand ionic conductivity in ceramics.

Eventually, he was persuaded to join the UC Davis College of Engineering full-time. “UC Davis is one of the greatest centers for research; its visibility is getting bigger and bigger.”
CREATIVE COLLABORATION:

CRISTINA DAVIS CONDUCTS RESEARCH THAT MAY REVOLUTIONIZE THE MONITORING AND TREATMENT OPTIONS FOR MILLIONS WHO SUFFER FROM ASTHMA

By Derrick Bang

CRISTINA DAVIS doesn’t think small. As an associate professor in the UC Davis Department of Mechanical and Aerospace Engineering, Davis hopes her current research will completely revolutionize the monitoring and treatment options for those who suffer from a malady quite common to Northern California residents: asthma.

“I like working on cutting-edge projects that have large impacts,” she admits.

Her ambition has been noticed and rewarded. The Hartwell Foundation recently honored Davis with a prestigious Individual Biomedical Research Award, to help her develop — to quote from her research prospectus — a “safe and effective, noninvasive diagnostic health monitoring sensor for children with asthma, to improve their daily quality of life.”

PERFECT MATCH

And while UC Davis is favorably located within this geographical “hot spot” for adult and pediatric asthma, Davis was also drawn to the university for other reasons. “UC Davis is a perfect match for me,” she says. “It has a vibrant biomedical and biological sciences community. Being an engineer on this campus gives you a lot of great investigators to work with, thanks to the breadth of available talent.”

Although this specific project is new, Davis brings a wealth of experience to her efforts. “I’ve always worked on sensors and instrumentation,” she acknowledges.

After graduating with degrees in mathematics and biology from Duke University, she obtained a Ph.D. in biomedical engineering at the University of Virginia, in 1999. She then did a postdoctoral fellowship in electrical engineering and physiology at Johns Hopkins University, after which she was involved with several start-up companies and worked in industry for slightly more than half a decade. She then returned to academics and came to UC Davis.

The Hartwell Foundation award is furthering her goal to design new instrumentation for chemical diagnostic systems, with the desired outcome of improved medical care. “We’re doing two things simultaneously,” Davis explains. “First, we’re building an instrumentation and sensor platform. Second, we’re confirming and pursuing breath biomarker validation studies in pediatric asthma patients, which hasn’t been done before.”

This technical description obscures the simplicity of the anticipated end product: a hand-held sensor, no more intimidating than the inhalers becoming more ubiquitous among young asthma patients, which they’ll use in a similar fashion. “Children will be able to self-monitor their own asthma during the course of, say, a school day, and accumulate data that, in turn, will help their doctors fine-tune their inhaler regimens,” Davis explains. “This will help determine whether their current drugs are doing an efficient job on a day-to-day basis.”

And it’ll be as simple as breathing into this sensor. “We’ll look at two fractions of exhaled breath,” Davis continues, “the condensate that can be formed by condensing the aerosolized, liquid-containing fraction of breath; and the volatile compounds that are exhaled in the gas phase. We’ll have dual-analysis pathways in our device that will examine both fractions, and identify bio-markers of significance, to determine whether someone has poorly controlled asthma.”

Asthma is an excellent target, and not just because of a pressing desire to help children suffering from shortness of breath. “Asthma is one of the most common starting points for looking at breath diagnostics,” Davis explains, “because it is an extremely common pulmonary disorder.”

And while this particular project couldn’t be more cutting-edge — Davis envisions such sensor/monitors...
being part of, for example, a cell phone, and therefore theoretically able to instantly transmit the recorded data to a doctor's office — a comparable, if simpler, device already is in widespread use. We hear about it all the time, and hope never to face one: the breathalyzers used to detect alcohol consumption during roadside traffic stops.

“An alcohol breathalyzer looks at a single compound, and whether it exceeds a specific threshold,” Davis clarifies. “In our case, we'll look at multiple markers simultaneously. Conceptually, though, a breathalyzer is quite similar.”

Davis acknowledges that her proposal is aggressive, and that the time frame seems short. But she's not worried.

“In the three months since this started, we've already made terrific progress. We've begun designing the micro-scale sampling and analysis device, and have an excellent first-generation prototype for pieces of it.”

Davis anticipates completing clinical trials of the new device within three to five years. “I expect we'll then have a functioning prototype that will have been designed, from the outset, to be transitioned into industry for potential commercialization.”

Nor will that necessarily conclude her involvement. “I like to see things to fruition,” she admits, “so once we get to that point, I hope to continue working closely with industry collaborators.”

**CITRUS PROTECTION**

Many researchers would be content with one such project, but Davis is equally involved with a different sort of crisis: the disastrous threat to the world citrus crop, brought to these shores with the “citrus greening” catastrophe that could demolish Florida's fruit industry. This funded project is sponsored by the California Citrus Research Board and the Florida Research Council.

“We've been building mobile chemical sensors that can be taken out into the field, to monitor off-gas metabolites from citrus trees,” Davis explains. “The goal is to determine whether they're infected with specific pathogens such as HLB (huanglongbing, "citrus greening") or CTV (citrus tristeza virus). We're now in year three of a project to define the biomarkers of significance related to those diseases, and to tailor our mobile chemical sensor instrumentation to monitor for those biomarkers.” The next step: working with industry to make the commercial development of such sensors financially practical.

As with her asthma project, Davis is well positioned to make a positive impact on a contemporary real-world problem.

When meeting folks at a dinner party, Davis will introduce herself as a professor in the UC Davis Department of Mechanical and Aerospace Engineering. If pressed, she might explain that her job involves “measuring small amounts of stuff in complex environments ... which is hard, but achievable if you have good sensors and good informatics.”

And then, after a well-timed comedian's beat, she'll add, “It's not as glamorous as it sounds.”

Perhaps not. But the potential implications of her work cannot be overstated to parents who've been awakened, late at night, by the ghastly sound of their child struggling for air.
When San Francisco’s new Public Utilities Commission headquarters and administration building debuts at 525 Golden Gate Avenue in the fall of 2012, one design element—an external vertical “wing” stretching up to the roof—is guaranteed to draw plenty of attention.

This revolutionary feature also will draw plenty of wind, and that’s precisely the idea: The building’s numerous “green” elements will include external wind turbines designed to produce at least 7 percent of the energy required by this new SFPUC home.

And the wind analysis studies have included plenty of input from a UC Davis consulting team led by Bruce White, a professor of mechanical and aeronautical engineering, and former dean of the College of Engineering; and C.P. “Case” Van Dam, chair of the Department of Mechanical and Aerospace Engineering.

Their involvement makes perfect sense. White knows the winds of San Francisco better than those in his own backyard.

“Over the years, my UC Davis group and I have done a lot of consulting and advising on the winds in San Francisco,” explains White, who among other projects, conducted wind analysis for the site of AT&T Park, home of the San Francisco Giants. “We’ve actually been looking at this particular site for more than 10 years. A decade ago, we tested a model for pedestrian-level impact; through the subsequent years, we tested several building shapes, but no project ever materialized.

Then, just a few years ago, we — the UC Davis Wind Energy Collaborative — did a study for the California Energy Commission (CEC). Our critical finding: It was economically feasible to have wind-energy devices on key high-rises in San Francisco.”

The site for that report was Fox Plaza, just a few blocks away — and across the Civic Center Plaza — from the Golden Gate Avenue site. One of the SFPUC’s engineers, Masoud Vafaei, is a graduate of UC Davis who was aware of that study. This influenced the SFPUC’s decision to seek a second opinion on the new admin/headquarters building, after having obtained an earlier analysis by RWDD, based in Guelph, Ontario.

“At the time of that earlier RWDD analysis,” White recalls, “the SFPUC hadn’t nailed down the building’s shape or additional features, so they also contacted Case Van Dam for advice on what sort of wind energy device to use. So he was looking into that part of it, and of course we were aware of each other.”

By the time White and his team got involved, the building’s design was pretty much set. “One of my students, Ashishkumar Patel, built a physical model,” White continues. “The model is quite complex, with curved surfaces and articulations; it must be done accurately enough to get good wind velocity measurements.”

White’s sole regret is not having been brought in earlier. “It would have been nice to have had a hand in the architectural designing,” he admits. “That’s always been a sore area for architects: creative taste versus the practicality of function. Had we been involved earlier, we’d have been able to explore different options, which may have improved the results. In the future, I expect this to evolve; more wind engineers will get involved at an earlier stage of a building’s design.”

That small caveat aside, White can’t help being excited by this project, and with good reason: Upon completion, 525 Golden Gate will be unique.

“ALL CITIES HAVE THE ABILITY TO USE WIND-ENERGY DEVICES ON HIGH-RISES.”

Bruce White (right) and Ashishkumar Patel

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“To the best of my knowledge, this building will be the first of its kind in the world; a real statement about trying to generate zero-energy buildings. I expect it to be a Leadership in Energy and Environmental Design ‘platinum building’ upon completion; that’s the highest sustainable certificate that the U.S. government’s Green
Building Council offers for building efficiencies.”

(UC Davis has two LEED platinum buildings: the August A. Busch III Brewing and Food Science Laboratory and Gallagher Hall.)

Aside from a desire to reap the benefits of such an energy-efficient design, the SFPUC also intends its new headquarters to make a very public statement.

“San Francisco, in terms of being an environmentally conscious city, always has been a leader,” White says. “This project will reinforce that image. The SFPUC wanted to demonstrate that this is feasible; they want to show the way.”

The site will be familiar to anybody who has spent time in downtown San Francisco.

“Tenth and Market is known to be one of the windiest areas in San Francisco,” White laughs. “It’s anecdotally famous for high winds and kiosks rolling down Market Street, and for people being blown over. Three nearby high-rises — Fox Plaza, the Bank of American Data Center and the California State Automobile Association — funnel the wind through and redirect it down to the 10th and Market intersection. When the wind is coming in the right direction, it’s really something.”

But while this section of San Francisco enjoys such an intriguing reputation, that’s by no means essential for such wind-energy projects.

“In terms of applications for wind energy and renewables, every city is a potential candidate,” White explains. “You need only go up in elevation. Natural winds have a boundary layer effect: As you go up, the wind increases. Once you’re 200 feet or above, you get strong winds everywhere on Earth. Typically, the wind environment in urban settings isn’t of the higher quality required for wind farms. But the offsetting component is that you cut out the middle person: You generate power on the building, and utilize the power in the building. You don’t need to go to a power utility. You can be one-third as efficient as a wind farm, and still be economically feasible.”

Perhaps the most controversial aspect of wind energy facilities concerns the incidence — and dangers — of bird strikes. San Francisco, always progressive with respect to such matters, has taken this into account.

“The California Energy Commission has invested a lot of money and research to get the true facts on this,” White says. “Some fundamental principles have come from those studies. The major problem, it turns out, is that even though birds have incredible vision, they cannot perceive that turbine blades are turning. They can fly into them, not knowing they’re there. So, you don’t build a latticed tower; you build a streamlined tower that prevents birds from landing or nesting on them.”

The best way to address this concern, however, is to avoid horizontal-axis turbines, as is the case with 525 Golden Gate.

“The vertical axis design does not affect avian life, because it’s like part of a building, and birds don’t fly into buildings,” White adds. “Horizontal-axis turbines potentially would have generated better wind energy, but, politically, the vertical ones are more acceptable from both the safety viewpoint and the avian viewpoint. There should be very few bird kills, if any at all.”

White is optimistic that wind turbines can be integrated into new buildings in an aesthetically pleasing way, improving energy efficiency and realizing great commercial potential.

“While it’s true that San Francisco’s pedestrian-level ground winds are higher than in most cities — Chicago also has this feature — all cities have the ability to use wind-energy devices on high-rises. A tremendous world market could be developed.”
The College of Engineering at UC Davis awarded its Distinguished Engineering Alumni Medals to four notable alumni during the college’s commencement ceremony on June 10, 2011. The honors were presented to Alfred Chuang, Christopher Kane, Bryan Jenkins and David J. Kappos.

The Distinguished Engineering Alumni Medals, awarded annually, recognize alumni whose professional and personal achievements bring special honor to themselves and to the College of Engineering. Candidates are UC Davis engineering graduates with more than 15 years of professional experience, and with records of outstanding professional or technical achievement. They also must have rendered distinguished service to the engineering profession or the community, and have contributed in a significant way to enhancing UC Davis’ reputation.

Chuang received the Distinguished Engineering Alumni Medal for Achievement in Business. Chuang received his M.S. in Computer Science from UC Davis in 1986; he then founded BEA Systems, which achieved $1 billion in annual revenue and became one of the world’s largest independent software providers. Under his leadership, the company grew to 91 offices in 38 countries, with more than 18,000 clients worldwide. After the 2008 sale of BEA to Oracle, Chuang founded Magnet Systems, which received $12.6 million of financing from Andreessen Horowitz, an investment firm.

Kane received the Distinguished Engineering Alumni Medal for Academic Achievement. Kane received his B.S. in Mechanical Engineering from UC Davis in 1985; he currently is professor of surgery, chief of urology, and director of the urology residency training program at the UC San Diego Cancer Center. Before joining that facility in 2007, he served as a military officer and surgeon in the medical corps in Operations Desert Shield, Desert Storm, Enduring Freedom and Iraqi Freedom. He served with distinction, earning numerous honors that included the Navy Commendation Medal and the Humanitarian Service Medal.

Jenkins received the Distinguished Engineering Alumni Medal for Achievements in Service. Jenkins received his M.S. and Ph.D. in Biological and Agricultural Engineering from UC Davis in 1977 and 1980, respectively. He currently is a professor in that same department, and since 2008 has served as director of the UC Davis Energy Institute. Jenkins has dedicated himself to his research, teaching and university service, while also informing public policy on bioenergy. He was an energy advisor for the 2003 California Governor’s Environmental Goals and Policy Report, provided California legislators with scientific input on biomass energy from 2003–07, and also was founding executive director of the California Biomass Collaborative.

Kappos also received the Distinguished Engineering Alumni Medal for Achievements in Service. Kappos earned a B.S. in Electrical Engineering from UC Davis in 1983. He now serves as both the Under Secretary of Commerce for Intellectual Property and Director of the United States Patent and Trademark Office. His duties involve advising President Obama, the Secretary of Commerce, and the administration on intellectual property matters.
AUTOMOTIVE NEWS HONORS ANDY FRANK

UC Davis professor ANDY FRANK has been selected for the first-ever “Automotive News Electrifying 100.” The Electrifying 100 consists of 100 of the most influential people behind the vehicle electrification movement. Frank’s contributions were acknowledged at a gala event on June 13, 2011, at the Henry Ford Museum in Dearborn, Michigan. The gala was part of Automotive News’ Green Car Conference, which took place June 13-14 at the Suburban Collection Showplace in Novi, Michigan. A professor emeritus in the Department of Mechanical and Aerospace Engineering at the UC Davis College of Engineering, Frank is widely regarded as the “father of the plug-in hybrid.” In 2006, he established a company, Efficient Drivetrains Inc. (EDI), which has licensed his inventions to develop them for the market.

ZUHAIR MUNIR RECEIVES LIFETIME ACHIEVEMENT AWARD

The American Ceramic Society (ACerS) selected ZUHAIR A. MUNIR to receive the 2011 ACerS W. David Kingery Award. The annual award recognizes a candidate’s career achievements in multidisciplinary and global contributions to ceramic technology, science, education and art. The society’s board of directors unanimously selected Munir for this honor. A former dean of the UC Davis College of Engineering, Munir also served as the college’s associate dean for graduate studies for 20 years. During his professional life, he has made a global impact in the field of ceramics through his research on the technology of field activation, and on the thermodynamics and kinetics of materials processing and synthesis, as well as his teaching in materials science. The American Ceramic Society recognized Munir’s accomplishments at the ACerS Honors and Awards Banquet, held October 17, 2011, in Columbus, Ohio. The Kingery Award includes a cash award of $5,000, a citation certificate and a glass trophy.

NATIONAL SCIENCE FOUNDATION GRANT

NINA AMENTA, professor of computer science, has been awarded a grant from the National Science Foundation for a project titled, “Shape Differences in the Biological Sciences.” In September, 2011, Amenta was named UC Davis director of CITRIS (The Center for Information Technology Research in the Interest of Society).

UC DAVIS ENGINEERING IS RANKED AMONG THE TOP 20 U.S. PUBLIC UNIVERSITY ENGINEERING PROGRAMS

– U.S. NEWS & WORLD REPORT 2011
MAHAJAN RECEIVES ASM INTERNATIONAL AWARDS

Subhash Mahajan, a distinguished professor in the Department of Chemical Engineering and Materials Science and a special assistant to UC Davis Chancellor Linda P.B. Katehi, has received the 2013 Albert Easton White Distinguished Teacher Award from ASM International. The award recognizes unusually long and devoted service in teaching, as well as significant accomplishments in materials science and engineering, and an unusual ability to inspire and to impart enthusiasm to students. The annual award was established in 1960, in memory of an outstanding teacher and research engineer who was a founding member and president of ASM International in 1921. ASM International also awarded its Gold Medal to Mahajan, at its annual event in October 2011.

CHEMICAL ENGINEERING AND MATERIALS SCIENCE, NEW CHAIR

Ahmet Palazoglu was named chair of the UC Davis Department of Chemical Engineering and Materials Science for a three-year term beginning September 1, 2011. Professor Palazoglu will succeed Professor Robert Powell, who served as chair for nine years.

The National Science Foundation (NSF) has selected 21 teams for the inaugural class of the NSF Innovation Corps (I-Corps) awards, including a UC Davis team, Inserogen, one of two University of California teams selected. NSF I-Corps teams will receive guidance from private- and public-sector experts; participate in a specially designed training curriculum; and receive $50,000 to begin assessing the commercial readiness of their technology concepts. The UC Davis Inserogen team includes principal investigator Karen McDonald; doctoral student Lucas Arzola, as the entrepreneurial lead; and Vasilis Voudouris, the founder and managing director of Vereniki Solutions, as their mentor. Inserogen’s technology focuses on rapid, cost-effective production of recombinant proteins, such as vaccines or therapeutic proteins, in tobacco or other plant materials.

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Lucas Arzola and Karen McDonald
CAREER AWARDS TO COLLEGE OF ENGINEERING FACULTY

Recipients of 2011 NSF CAREER awards from the UC Davis College of Engineering include ILKE ARSLAN, an assistant professor in the Department of Chemical Engineering and Materials Science; RICARDO H. R. CASTRO, assistant professor with the Department of Chemical Engineering and Materials Science; TODD GREEN, assistant professor in the Department of Computer Science; TINA JEOH, assistant professor in the Department of Biomedical Engineering; and WILLIAM RISTENPART, assistant professor in the Department of Chemical Engineering and Materials Science.

The National Science Foundation recognized the research excellence of several junior faculty in the College of Engineering in 2010–11. The Faculty Early Career Development Program (CAREER) offers the National Science Foundation’s most prestigious awards in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations. Such activities should build a firm foundation for a lifetime of leadership in integrating education and research. With this year’s award cycle, the College of Engineering has 46 recipients of Early Career Awards from the National Science Foundation.

THREE ENGINEERING FACULTY RECEIVE HP LABS AWARD

Three UC Davis College of Engineering faculty have received grants from the 2011 Innovation Research Program of HP Labs. The UC Davis faculty selected for the fourth annual Innovation Research Awards are JOHN OWENS and CHEN-NEE CHUAH, of the Department of Electrical & Computer Engineering; and PRASANT MOHAPATRA, chair of the Department of Computer Science. Based on an open, competitive call for proposals, the Innovation Research Program (IRP) is designed to create opportunities for researchers around the world to engage in groundbreaking collaborative research with HP. The program creates opportunities for faculty and students at leading colleges, universities and research institutes worldwide, to conduct breakthrough collaborative research with HP. In 2011, the IRP attracted 626 proposals from 525 researchers in 232 universities and more than 30 countries.

YOUNG FACULTY AWARD

YAYOI TAKAMURA, an assistant professor in the Department of Chemical Engineering and Materials Science, has been chosen by the Defense Advanced Research Projects Agency to receive the Young Faculty Award for her proposal, titled “Interface Controlled Functionality in Perovskite Oxide Superlattices.”

CHANCELLOR FELLOWS

XIN LIU, associate professor in the Department of Computer Science, and ALEXANDER REVZIN, associate professor in the Department of Biomedical Engineering, have been honored as Chancellor Fellows at UC Davis for 2012.
Nobody believed that accelerometers were sensitive; it was assumed that a hacker might be able to determine if you were sitting, standing or walking, but that wasn’t really an issue.

“But one day, about a year ago, Lian and I wondered if accelerometer information could determine what a person was typing. The most valuable data you type is your password, so we began to investigate whether it might be possible to ‘sniff’ a password from the accelerometer data.”

The answer: an uncomfortable yes.

As reported in August 2011, Chen and Cai have developed an algorithm — a working prototype — that sniffs user keystrokes by measuring the wiggles, waggles and vibrations recorded by a smartphone’s accelerometer.

“We had to overcome some problems,” Chen admits. “First, not all accelerometers are of the same quality; some aren’t as stable. We had to try different phones, until we found one with good accelerometers. Then we had to figure out how to extract the signal from all the ‘noise’ of the accelerometer. That meant signal processing, but neither of us was an expert in that, so we had to teach ourselves.”

The result, after a year of work, was verifiable proof of concept. With a bit of refining, Chen therefore expects that the technique could be made to work on all other phones, even those with lesser-quality accelerometers.

Besides, hardware improves constantly. “It wouldn’t surprise us if, a few years down the road, all accelerometers are better. And if they get more stable — more precise — that’ll make our algorithm even more valid.”

The unfortunate consequence of Chen and Cai’s discovery, of course, is that hackers are just as likely to read about it ... and set about exploiting it. And individual users, no matter how careful, can’t reasonably change their typing styles any more easily than their signatures. Revealing this weakness, therefore, is only part of the process: Getting the word out is equally important.

“The first fix is to simply tell people: both vendors and users,” Chen explains. “Everybody needs to understand that accelerometer data must be protected like other data. Most users, for example, would consider a smartphone’s microphone as a source of confidential information. Therefore, by default, most apps don’t have access to the microphone; if you download an unknown app that asks for the microphone, you should be suspicious.

“But that isn’t the way the accelerometer data was envisioned, so it’s readily granted to any application that requests it. So the first fix is to explain that accelerometers do have sensitive data that could reveal passwords, and that this data should not be given out easily.”

The long-term fix is more problematic, since numerous applications legitimately require accelerometer data. As Chen acknowledges, “We’re better at discovering vulnerabilities than at supplying procedures that will guarantee a secure system.”

Even so, they’re investigating possible solutions.

“The data could be divided into two levels of precision. Androids, for instance, produce two sources of GPS data: fine and coarse. The fine data, the best the sensor can deliver, places the user within a couple of meters. The coarse data places the user within a couple of miles. Perhaps the same could be done with accelerometer data; maybe most applications would be happy with ‘coarse’ data.”

Chen and Cai expect to complete their accelerometer research within a year, which demonstrates an enviable aspect of this field: Unlike many other scientific endeavors, which could span years and decades before fruition, computer security work must be a much faster process. Problems can be spotted and sometimes even solved in months; indeed, this is essential, since hackers work at the same speed.

Mostly, though, the smartphone marketplace is an entirely different ecosystem. Savvy desktop and laptop computer users understand the need for vigilance, in terms of being suspicious of any unsolicited email attachments; in marked contrast, smartphone users are blithely encouraged to download any and all of the hottest new apps. Once again, a good first step will involve educating the end user.

“But we can’t disclaim our own responsibility as security researchers,” Chen insists. “We must make products as secure and bulletproof as possible. We should include features that make it harder for hackers to attack, and make it more difficult for users to make security mistakes.”

One aspect of this work is obvious.

“It’s a never-ending fight,” Chen laughs, “which is very good news for security researchers: lifetime employment!”