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Inexpensive Technology Makes Daily Life Easier for the Visually Impaired

BY AMY BICKERTON

On a snowy Pittsburgh evening, Priya Narasimhan watched a blind man slowly board a bus. The man's struggles sparked in the young professor an idea for a cost-effective technology that will improve the quality of life for visually impaired people.

Narasimhan, an assistant professor in ECE, develops embedded technologies, which are used in cell phones and personal digital assistants (PDAs). She and her students are integrating these common devices into a system that can help blind people with everyday challenges such as catching a bus or shopping for groceries.

Using her own money, she founded a research project named Trinetra, which is an alias for the Hindu god Shiva. Shiva is characterized by a third eye that graces his forehead. This eye of "higher perception" serves as a source of light and energy even when his other two eyes are engulfed in darkness. Narasimhan and her students are employing a collection of off-the-shelf embedded systems to give visually impaired people the means to perform everyday tasks independently.

Trinetra relies on three devices: a pen-sized barcode reader, a smart cell phone, and a Bluetooth headset. Here's how it works: A person picks up a can of soup in a grocery store and uses the barcode reader to scan the UPC symbol on the can. The barcode reader sends the UPC data to the cell phone via Bluetooth. The cell phone then accesses a free UPC symbol database over the Internet — such as www.upcdatabase.com. The database translates the symbol into a product name, which is relayed back to the cell phone. Text-to-speech software installed on the phone converts the product name into words spoken directly into the user's ear via the inconspicuous Bluetooth headset.

A common problem of many assistive technologies is cost. "Products that specifically target the blind are more expensive than their counterparts for the sighted population because of the additional effort and cost required to adapt and test them," says Narasimhan. This isn't a problem with Trinetra because the system leverages existing, inexpensive technologies.

Narasimhan's passion for helping people is shared by her research group: students Patrick Lanigan (INI) and Andrew Williams (ECE) and research programmer Aaron Paulos of ECE. While the researchers were equipped with good intentions and technical knowledge, they wisely enlisted Dan Rossi onto their team. Rossi, a database system administrator at Carnegie Mellon, has been blind since he was seven. "We have involved a blind person from day one in the design of the project so that blind people's needs and inputs have been factored into our design in an intrinsic and fundamental way,"

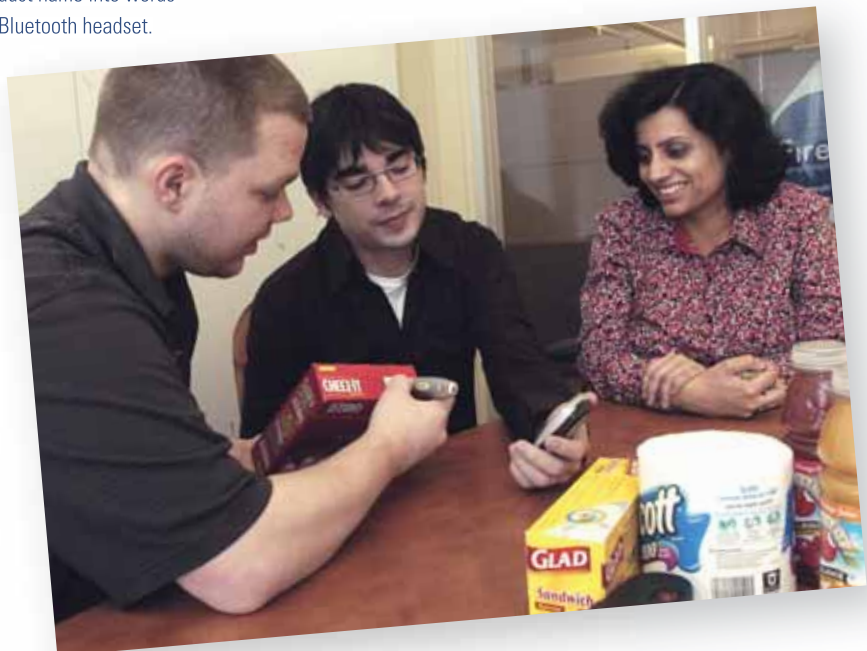
says Narasimhan. Rossi helped Narasimhan understand that a lot of assistive technologies do not involve blind people in the design process, only bringing them in for testing *ex post facto*. The result is impractical technology that can actually inhibit the blind person — such as incorporating heavy sensors into a cane, thereby affecting its torque.

"You cannot imagine the real impact of this," says Rossi. "When shopping with a store assistant, it is nearly impossible to browse products. I ask for what I need, and they take me to that product, and that's it. A device that can tell me about anything in the store is incredible."

Trinetra has been deployed in Carnegie Mellon's convenience store, Entropy, and now the team intends to incorporate GPS tracking into the Trinetra system and test how well it alerts passengers as to the location and arrival times of Carnegie Mellon's shuttles.

"My aim is for Trinetra to become one of the research thrusts of my research group, so that we can explore the application of embedded, distributed technologies to improve the quality of life for people," Narasimhan says. For the past year, she has not had to worry as much about financing the project with her own money. Trinetra was one of three projects at Carnegie Mellon to be granted \$7,500 from the Pennsylvania Cyber Security Commercialization Initiative (PaCSCI). The PaCSCI mission is to help grow Pennsylvania's technology-based economy by funding university teams and start-up technology companies.

Like its light-bearing namesake, Trinetra's future is certainly bright.



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New Website Provides Fast Facts About Traffic Safety Risks

The Federal government keeps tabs on our driving habits. We have reliable data that provides personal information about drivers, such as their gender, age, when, where and what they drive, and number of trips they take. Similarly, we have facts about fatal vehicle accidents. But what we didn't have, until now, is TrafficSTATS, a quick and easy-to-use Website that calculates, on the fly, travel safety risks.

"People don't understand what risk is, and that is one of the motivations for this site," says David Gerard, of Engineering and Public Policy and one of the site's creators. According to Gerard, risk is more than a general number that expresses how many people die while traveling. For example, in 2004, 3,779 people died in motorcycle accidents, while 18,819 deaths were attributed to passenger cars. More people die in cars, but are cars riskier? To find out, you have to consider several factors: number of deaths and miles traveled (or the number of trips taken or time on the road). If you look at deaths per miles traveled, in passenger cars, there were 1.05 fatalities per million miles traveled, whereas, with motorcycles there were 32.61 fatalities. This makes motorcycles 30 times riskier than cars.

"There's this chasm between perception and reality," says Gerard, and this point was highlighted in an earlier study conducted by Paul Fischbeck, the director of EPP's Center for the Study and Improvement of Regulation. Fischbeck demonstrated that while school buses are the safest vehicles for kids to travel in, the public, for the most part, is unaware of this. When a school bus crashes, it's national news, and that thought lingers, creating an erroneous perception about bus safety. By pinpointing, retrieving and comparing figures, TrafficSTATS gives users an unvarnished look at what is really happening on our highways.

"What we are finding is contrary to a lot of the myths that are out there," says Fischbeck, "We can do risk comparisons that nobody has ever looked at before, and we can do them instantaneously." Yet, now that we can produce this information, new questions arise: what do we do with it and what does it all mean?

As expected, policy makers are interested in this research, and already safety officials from Ohio and Washington state have contacted the CIT researchers. Providing decision makers with reliable information has been a long-standing goal of our Engineering and Public Policy department, and that's why the researchers want to take the project to the next level: they want to

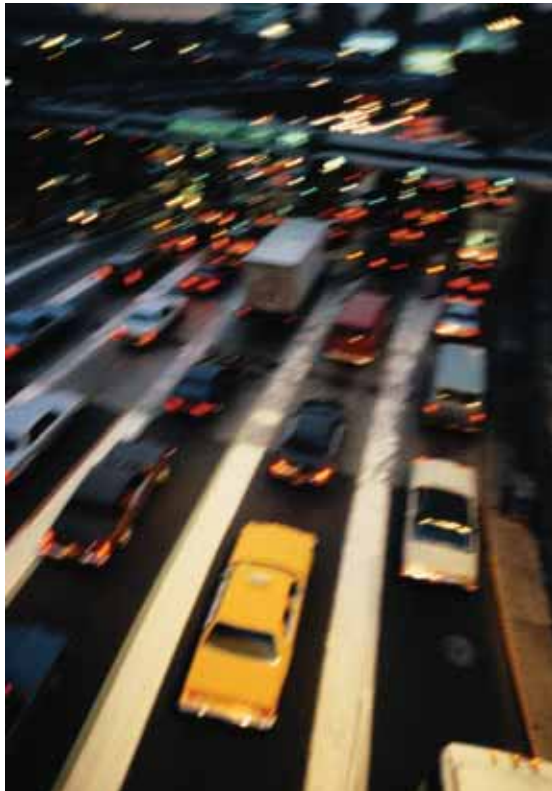
understand why the results are what they are. For example, there is an undergraduate project currently underway that is exploring why the risks associated with pick-up trucks are higher than the risks associated with other vehicles (except motorcycles). "We are trying to figure out if pick-up trucks are driven by the worst drivers at the worst time of the day or is it something inherent, inside of the truck itself?" says Fischbeck. Are pick-up trucks riskier because of the driver, the vehicle or are their situational causes?

Fischbeck, Gerard and the other authors of the study, Randy Weinberg, the director of Carnegie Mellon's Information Systems Program, and consultant Barbara Gengler, of Multidimensionality, LLC, want to broaden the capabilities of the Website by expanding its database, which Fischbeck calls "the heart of the system." Presently, TrafficSTATS incorporates data from the Fatality Analysis Reporting System (FARS) and the National Household Travel Survey (NHTS), which can tell us about driving behavior and fatalities. The team would like to add data from the General Estimate System (GES), which is maintained by the National Highway Traffic Safety Administration. The GES would

allow for calculations that include injury and property damage. TrafficSTATS would certainly benefit from the addition of this new data, and on the flipside, the Website would help prove that the traffic information that the government gathers, which is expensive to collect, is of value to the public. The researchers believe that their work could be of interest to a number of stakeholders, including the media, safety advocates, auto manufacturers, and perhaps even the insurance industry. "We want to show that our work has public interest and policy implications," says Fischbeck.

TrafficSTATS is available to the public at www.aaafoundation.org/trafficSTATS.

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Microstructure of Materials May Predict the Lifespan of Aircraft



Anthony D. Rollett, a professor in the Materials Science and Engineering Department, has developed a computational method that helps the U.S. Navy decide when to overhaul or retire aircraft.

Rollett and other researchers at Carnegie Mellon have refined a system already developed in collaboration with Pittsburgh-based Alcoa that maps the microstructure of materials into a three-dimensional digital material. The digital material is akin to a computer program, which allows researchers to test the material *ad infinitum* via computational methods. The novelty of Rollett's research is that he can create many different examples of the material and capture its variability. The results are used in statistically-based systems that track the lifespan of an aircraft.

Many Navy aircraft are more than 30 years old, so military officials are seeking a reliable system for reducing the risks and costs associated with ensuring the safety of its aircraft. "We are looking for any kind of defect in critical airplane parts," says Rollett. For example, many Navy aircraft endure repeated aircraft carrier landings. Some aviation experts call these "controlled crashes" and they put significant stress on airplane frames. Another source of wear and tear on aircraft parts is when moisture combines with dirt or salt, creating the perfect condition for corrosion.

The project is funded by a \$500,000 research grant from the United States Defense Advanced Research Projects Agency (DARPA).

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Invasion of the *Waal* Bots

In a room cluttered with screws, wires, and electronic odds-and-ends, the Gecko Lab looks more like a storeroom than the birthplace of an ingenious high-tech achievement: wall-climbing robots.

Wall-walking robots aren't exactly new — robots that rely on suction or magnetic adhesion are used today to inspect and clean dangerous environments, like petroleum storage tanks. These industrial robots, however, have drawbacks that prevent them from working in many environments. But the days of robots slip, sliding away are just about gone thanks to research in the Mechanical Engineering department that will allow the next generation of wall-walkers to creep across just about any surface on earth or in space.

The novel robots, called *Waal* Bots, represent the second stage of Professor Metin Sitti's research that began when he developed the now-patented polymer material that mimics a gecko's ability to stick to surfaces. Geckos have billions of self-cleaning tiny fibers on their toes that bend and fit cozily into surface variances, creating dry adhesion via molecular forces called van der

Waal forces. (Sitti's robots earned their moniker from these forces and not from walking up walls. *Waal*, not *wall*, *get it?*) Like the reptile, which can effortlessly lift its foot up and down, the adhesive material, that's called "gecko tape" can repeatedly attach and detach from surfaces.

After figuring out how to fabricate the adhesive, which entails attaching nanofibers onto the ends of microfibers, Sitti says, "We asked ourselves what kind of robot can use this material to climb on surfaces like a real gecko?" He and his doctoral students, Mike Murphy and Ozgur Unver, developed a number of prototypes. One of the more optimal designs, Sitti describes as having "a triangular wheel with legs." On the end of each leg is a flat footpad that is coated with gecko tape. Describing the locomotion process, Sitti says, "To attach and detach, you have to peel [the material] like tape. What happens is when the material comes to the surface, there is a pressing force and then it [the wheel] sticks. And when you apply more torque, it will start to peel."

The success of the prototypes have given Sitti the confidence to say that commercialization of the machines is likely within two to three years, however, there is still plenty of work to do. Presently the 30- to 100-gram robots move at a speed of about five centimeters per second and the researchers want to increase that, but for now, speed is a secondary concern. "Climbing is one of the hard things. You are fighting against gravity. And surfaces are really nasty and dirty. You have to go over edges and over curved surfaces," explains Sitti. On the other hand, hiking up clean, slick surfaces, like glass or ice, is no problem for the *Waal* Bots, whose only Achilles' heel is Teflon. Sitti says he can live with this because geckos can't climb up Teflon, either.

Once the complex mechanics of the robots' locomotion are mastered, the devices will be outfitted with sensors and other tools that will allow them to perform the tasks for which they were designed: monitoring, inspecting, maintenance and cleaning, search and rescue, and surveillance. While space and military applications are inevitable, robots that help people take care of their homes are plausible, too. Sitti's long-term goal is to make teams of hundreds of "small, agile, powerful, and inexpensive robots that communicate to each other" as they canvass large areas. This futuristic vision of swarming intercommunicating mini robots begs the question: Which creatures in the animal kingdom will inspire Sitti next?



Left to right: Mike Murphy, Ozgur Unver, and Metin Sitti