Californians -- and their cell phones -- will help computer scientists monitor air pollution

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UC San Diego computer scientists are creating a network of environmental sensors that will help you avoid air pollution hot spots in everyday life. This is "CitiSense" -- the vision of computer scientists from the UC San Diego Jacobs School of Engineering. The team won a $1.5 million grant from the National Science Foundation to solve the technical challenges that stand in the way of applications that merge our cyber and physical worlds. The CitiSense leadership team (l-r) includes UC San Diego computer science professor William Griswold, computer science professor Ingolf Krueger, UC San Diego School of Medicine/Calit2 professor Kevin Patrick, computer science professor Tajana Simunic Rosing and computer science professor Hovav Shacham. (Not pictured: computer science professor Sanjoy Dasgupta). Credit: UC San Diego Jacobs School of Engineering

You want to go for a run, but you don't want to run in polluted air that might aggravate your asthma. University of California, San Diego computer scientists are creating a network of environmental sensors that will help you avoid air pollution hot spots that exist exactly when you are planning your route. The system will provide up-to-the-minute information on outdoor and indoor air quality, based on environmental information collected by hundreds, and eventually thousands, of sensors attached to the backpacks, purses, jackets and board shorts of San Diegans going about daily life.

This is "CitiSense"—the vision of computer scientists from the UC San Diego Jacobs School of Engineering. The interdisciplinary team recently won a $1.5 million grant from the National Science Foundation (NSF) to solve the many technical challenges that stand in the way of applications that merge the cyber and physical worlds.

"San Diego County has 3.1 million residents, 4,000 square miles, and only five official EPA air quality monitors. We know about the air quality in those exact spots but we know much less about the air quality in other places. Our goal is to give San Diegans up-to-the-minute environmental information about where they live, work and play—information that will empower anyone in the community to make healthier choices," said William Griswold, the principal investigator on the grant and a professor in the Department of Computer Science and Engineering (CSE) at the UC San Diego Jacobs School of Engineering.

The goal of CitiSense is to build and deploy a wireless network in which hundreds or thousands of small environmental sensors carried by the public rely on cell phones to shuttle information to central computers where it will be analyzed, anonymized and reflected back out to individuals, public health agencies and San Diego at large. At the same time, the sensor-wearing public will have the option to also wear biological monitors that collect basic health information, such as heart rate. This combination of sensors will enable the team's medical team to run exacting health science research projects, such as investigating how particular environmental pollutants affect human health. Dr. Kevin Patrick from UC San Diego's California Institute for Telecommunications and Information Technology (Calit2) and the UCSD School of Medicine will lead the medical efforts.

Building a large-scale system that integrates sensors and other digital technologies into the physical world will require advances in a number of computer science areas including power management, privacy, security, artificial intelligence and software architecture. "It is a tremendous challenge to integrate a number of technologies and then deploy them outside—in the wild," said Griswold.

Mobile phones and other handheld devices, for example, are traditionally designed to serve one person—the user. Including these electronics in advanced computing systems that have other priorities will require new power and workload management strategies. Computer science professor Tajana Simunic Rosing and her graduate students are developing systems to ensure that the phones and other mobile devices serving as stepping stones between environmental sensors and the centralized computing infrastructure will not drop calls or suffer other hits to performance.

Rosing's team is also investigating how sensors fixed in the environment—rather than carried around by the general public—might be powered by solar, wind, or vibrational energy instead of batteries. In addition, the computer scientists are considering how these fixed sensors might rely on nearby handheld devices to send environmental information to central computers.

Capturing high quality data from sensors in uncontrolled environments is another challenge the computer scientists face. "Sensors will differ. Sensors will fail. People will breathe on them. And so there is the question of how you get good data in these conditions. We have to find a way to process the data to remove the noise," said Griswold, who noted that computer science professor Sanjoy Dasgupta and a team of student researchers is using statistical artificial intelligence (AI) to do just this.

Computer science professor Hovav Shacham will lead a team focused on security and privacy issues, which are particularly challenging given the limited computational power of sensors and other embedded devices.

Software architecture and cyberinfrastructure are additional areas in which breakthroughs will be needed. The computer scientists are developing new approaches to writing code for software systems that are open and flexible yet private and secure.

For example, if someone develops a new application for monitoring carbon dioxide, the computer scientists want to be able to drop the application into the system and have it not only work—but interact with existing systems in terms of data, power management and workflow. Computer science professors Ingolf Krueger and William Griswold are leading these efforts. In part, they are building on Krueger's previous work in service-oriented architecture, which can keep various components—like machine learning, power management and security code—much more separate than in traditional software systems, where functional elements are often so woven into the source code that it is difficult to quickly update any one aspect of the software.

"We are addressing major problems of the day of tremendous social, environmental and economic importance. When you attach the science and engineering to the problems of the day, it drives the research in a very exciting way," said Griswold.

Source: University of California - San Diego (news : web)