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Engineering News: May 2007

Researchers in the News

In each issue, Engineering eNews will feature members of our engineering community who are conducting groundbreaking or newsworthy research.

Technology May Bridge Emotion Gap between Humans and Computers

When the screen freezes and the e-mail you were typing gets lost in cyberspace, you may want to curse and kick your computer. Computers can't sense human emotion and may lose all your valuable work without registering your frustration. Erin Treacy is a Tufts University School of Engineering graduate student trying to bridge the gap between human emotions, like frustration, and computer functionality.



"When you're communicating, you naturally give out a lot of information besides speaking," Treacy says, listing body language and inflection. "You're doing a lot of other things that give clues." But the computer doesn't pick up any of that information, she says. fNIR technology, which uses near-infrared light to detect where the brain is active, may be able to be the translator between human and computer.

"With fNIR, hopefully we can make human-computer interaction a little bit more natural, fun and interesting without it making it any more difficult," says Treacy.

As part of the School of Engineering's Computer Science M.S./Ph.D. program, Treacy is studying the use of fNIR (pronounced "eff-near") as part of the Human-Computer Interaction Research Group, led by professor Robert Jacob. Treacy and her research group, which includes graduate students Leanne Miller Hirshfield and Audrey Girouard, want to know if fNIR could make computers responsive to human emotion.



The fNIR device, which looks like a futuristic headband, uses LEDs to send near-infrared light through the forehead at a relatively shallow depth—only two to three centimeters—to interact with the brain's frontal lobe. Light usually passes through the body's tissues, except when it encounters oxygenated or deoxygenated hemoglobin in the blood. Light waves are absorbed by the active, blood-filled areas of the brain and any remaining light is reflected to the fNIR's detectors. "fNIR, like MRI, uses the same idea that blood flows to the area of the brain that's being used," says Treacy.

Though fNIR technology was originally developed in the 1950s to study breast cancer, its use as a device to track emotional states is a new area of research. As a result, Treacy said her group first wanted to answer the question: "This device is so new, will we be able to get a good enough signal to get a good idea of emotional states?"

Through the initial testing in collaboration with the School of Engineering's biomedical engineering department, Treacy's group obtained reliable signals from the fNIR device. This confirmation will allow the group to design and experiment with human-computer interfaces.

Treacy's long-term goals are to use fNIR to make human-computer interaction truly

dynamic. An HCI system using fNIR could react to the brain's activity and change its display as a result. "I really want to build an actual system that looks at this in real time and picks up the user's cues," says Treacy, though she points out a potential stumbling block: "Even if you realize that someone's being frustrated, how much can you change something before you frustrate them again?"

The HCI field, fNIR, and the support of her Tufts advisors will continue to keep her interested as she completes her doctoral degree, Treacy says. "I think our brain is so complex the more we can find out about it and pick up information on what I'm doing at a given time, the better our designs could be."

Profile written by Julia C. Keller, Tufts School of Engineering
Photos courtesy of Tufts Computer Science Department

Don't Drink the Water: Shafiqul Islam studies Bangladesh's arsenic-contaminated water supply

"Water, water everywhere, but not a drop to drink." Perhaps one person at Tufts University who truly relates to this verse is Shafiqul Islam, Professor of Civil and Environmental Engineering and Associate Dean for Research. Islam uses an interdisciplinary approach to address one of the most relevant contemporary problems: scarcity of and access to clean drinking water.



"Many water problems are often framed within a contested terrain in which many actors compete to protect their own—often conflicting—economic, political and other interests," says Islam. With Tufts University's unique combination of highly ranked Schools of Engineering, Arts and Sciences, and the Fletcher School of Law and Diplomacy, the school is poised to blend these domains of knowledge and make an impact.

Since 1999, Islam has been leading an international scientific research group to investigate why arsenic is seeping into Bangladesh's water supply. While a professor at the University of Cincinnati, Islam visited Bangladesh with a MIT colleague, Charles Harvey, to understand the nature and extent of Bangladesh's arsenic problem. In the United States, the allowable standard for arsenic is 50 parts per billion; in many of the Bangladeshi wells, arsenic levels reach 500 to 1,000 parts per billion—and some contain as high as 2,400 parts per billion. Today in Bangladesh, more than 40 million people are affected by arsenic-contaminated drinking water, according to Islam.

Arsenic exists everywhere in nature, and usually does not cause any health problems in its solid state. So why is it seeping into water in Bangladesh? One possibility, says Islam, involves changes in water usage for growing rice crops in Bangladesh. In the last 30 years, farmers have started to grow a new variety of rice that is irrigated with groundwater, as opposed to the previously grown variety which uses rain and surface water.



India's groundwater table fluctuates greatly and drops during the dry season. This fluctuation causes deeper groundwater to be replaced by surface water, rich in organic material. The organic material settles deep into the earth, which then transforms previously insoluble arsenic into a soluble form capable of infiltrating the water supply.

As a result, Islam and team

members from MIT and Bangladesh found that groundwater between 80 and 150 feet below the surface in Bangladesh, contains arsenic in very high concentrations; however, they found little arsenic near the surface and not much at levels below 200 feet. "A quick solution would be to dig wells 400 feet or deeper, where there is virtually no arsenic. But it's very expensive," said Islam. Most affected Bangladeshis continue to use well water because there simply are no other viable water sources, Islam says.

A year after the team's initial measurements, they received National Science Foundation funding to explore the causes of high arsenic contamination in the Ganges River basin. In 2002, Islam received a Fulbright Fellowship to continue to work on the problem. Since coming to Tufts University in September 2004 as the first Bernard M Gordon Senior Faculty Fellow in Engineering, Islam has continued his research in Bangladesh and on other projects involving water.

Is there is solution to Bangladesh's arsenic problem? Islam says he is pessimistic. He points out that the main problem may be the lack of political will on the part of the Bangladeshi government. "Since the most affected areas are rural villages, the issue never gets taken up seriously by the people in power," says Islam. "Science and technology will not solve major water problems," Islam says, "Policy operating in a vacuum without inputs from science cannot solve these problems either."

Profile written by Sujata Tuladhar, F'08
Photo of Shafiq Islam by Tufts University Photography

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