Researchers send messages using household chemicals

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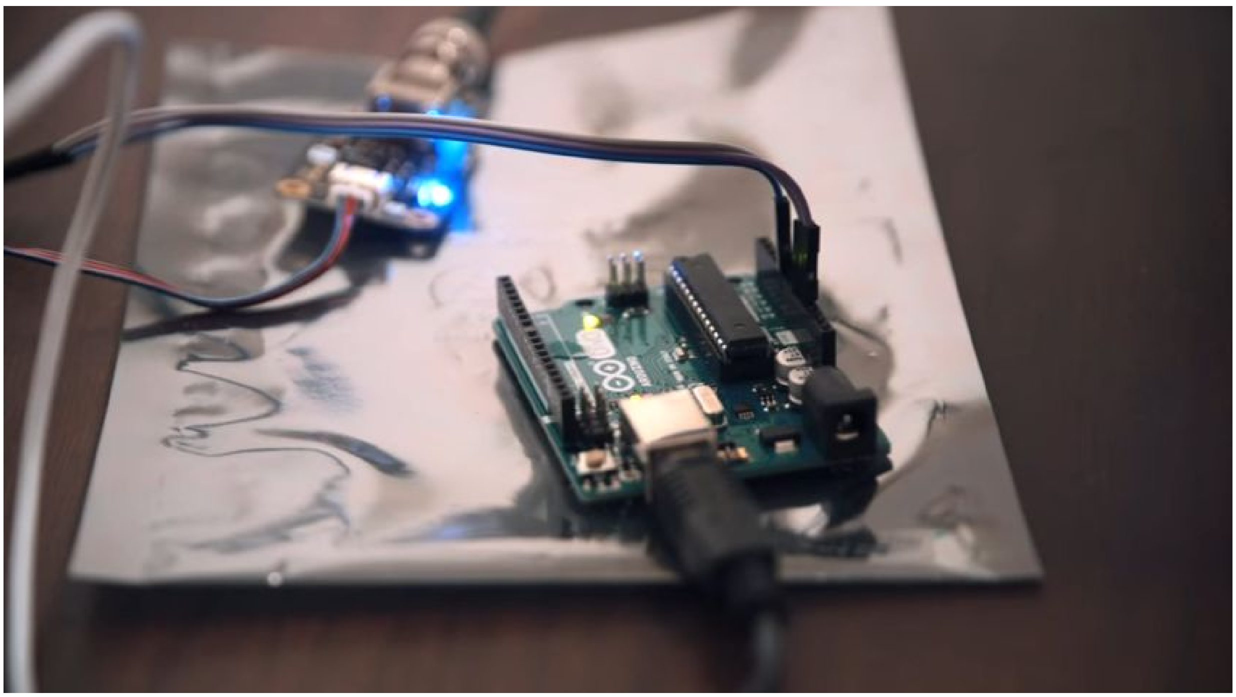

Nearing the completion of his master's degree in computer engineering and computer science at York University in Ontario, Canada, Nariman Farsad was considering pursuing further study elsewhere. But his supervisor, Andrew Eckford, convinced him to stay by suggesting an odd line of research.

The idea? Figure out how to create a system that uses chemicals to transmit messages.

"When he explained it, it was intriguing to me because it was very new and seemed futuristic," said Farsad, now a post-doctoral fellow at Stanford, in the lab of Andrea Goldsmith, professor of electrical engineering. "I thought, OK, it's a high-risk, high-reward project, so why not?"

This remains relatively uncharted territory, studied by few other researchers in the world. At York, Farsad built the first ever experimental chemical texting system, which used vodka to send its messages. Now, as a member of the Wireless Systems Lab at Stanford, he has a faster version that communicates through pulses of glass cleaner and vinegar.

There are challenges yet unmet by the current system and another, bacteria-based system in the making. In the midst of this work, Farsad and Goldsmith relish envisioning the strange and wonderful potential of data exchange through chemicals.

Simple idea, complex execution

In essence, the chemical communication system is a straightforward concept. Like many systems, it relies on a binary code to relay messages. But instead of zeros and ones, it sends pulses of acid (vinegar) or base (glass cleaner). The researchers type their desired message in a small computer. The computer then sends a signal to a machine that pumps out the corresponding "bits" of chemicals, which travel through plastic tubes to a small container with a pH sensor. Changes in pH are then transmitted to a computer that deciphers the encoded message.

Farsad chose these specific chemicals because they are easy to obtain and they cancel each other out at the receiving end of the system. In his vodka messaging machine, the signal would build up to the point that the receiving end was too saturated with vodka to receive more messages.

The complications of this type of system, like the vodka hurdle, are largely due to the fact that it's completely new. Goldsmith has spent her entire career working in wireless communication. Chemical messaging offers a new twist on familiar problems.

"Every problem that we've addressed in traditional wireless communications over the last three or four decades is really different now because it's a different mode of communicating," Goldsmith said. "As so, it opens up all of these new ways of thinking about the optimal way to design this type of communication system."

One of the most pressing challenges is figuring out how to separate the signal from the noise at the end of the transmission. Upgrading from vodka to the acid-base combination was an immense improvement but the chemicals still leave residue behind as they move through the channel.

A science-fiction solution

If asked, Goldsmith and Farsad could probably imagine a dozen ways in which chemical messaging could change the way we transmit and receive information. It's wireless and affordable, and it could work without electronics. That means it could function in places where typical electromagnetic communications systems struggle, such as under water or in places containing lots of metal.

Fantastic possibilities they've already discussed include leaving secret messages that others wouldn't even know to look for, having robots communicate with trails of liquid text, or being able to fall back on chemical communication in the extremely unlikely scenario that our electric grid is knocked out by a terrorist attack.

"It's just so 'out there,' like science fiction," Goldsmith said. "What are all the exciting ways that we could use this to enable communication that is impossible today? That's what I would want someone to walk away thinking about."

The researchers are currently looking into how chemical communication could advance nanotechnology. Cost-effective nanotechnology already exists that may someday go inside the human body. But these devices are so small that, in order to communicate, they have to be wired together or else depend on high-frequency signals, which could potentially cause organ damage. These signals also tend to only travel short distances and powering them has yet to be figured out. As an alternative, chemical-based data exchange could be self-powered, traveling throughout the body harmlessly – and undetectable by outside devices.

"This is one of the most important potential applications for this type of project," Farsad said. "It could enable the emergence of these tiny devices that are working together, talking together and doing useful things."

While working to improve their current chemical texting system, Goldsmith and Farsad are also collaborating with two bioengineering groups at Stanford to make human body-friendly chemical messaging a reality.

Provided by Stanford University

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