Micro-robots could go inside the body and track vital signs, professor says

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Every time University of Pennsylvania engineer Marc Miskin speaks about his research on miniature robots, someone asks the question: How does it compare to the submarine in "Fantastic Voyage"?

That's the fanciful 1966 sci-fi movie in which a tiny vessel makes an emergency journey inside the brain of an injured scientist. The incredible answer: The real-life bots, which Miskin developed with former colleagues at Cornell University, are about the same size.

Roughly one-quarter the size of a pixel on a standard computer screen, they are little squares of silicon with legs made from platinum and titanium, able to swim around inside your body and track vital signs.

At least someday, Miskin hopes. For now, they swim around on microscope slides in Miskin's lab at Penn, where he started in January as an assistant professor of electrical and systems engineering. The bots are equipped with miniature solar cells, allowing Miskin to power them with laser light.

Miskin recently presented his research in Boston at a conference of the American Physical Society. He designed the robots at Cornell as a post-doctoral researcher, working with colleagues Itai Cohen, Paul McEuen and Alejandro Cortese.

A million robots can be made from one 4-inch wafer of silicon using techniques adapted from the semiconductor industry, Miskin said at a news conference. They are so cheap to make—a fraction of a penny each—that he thinks of them like chemicals or medicines.

"It's a fundamentally different kind of robot," he said. "You can throw them away."

Other scientists who have heard presentations by team members are impressed.

Producing a three-dimensional device at that scale is a challenge, said David Gracias, a professor of chemical and biomolecular engineering at Johns Hopkins University. He likened the manufacturing techniques used by the Penn-Cornell team to a very small-scale version of origami—the Japanese art of paper folding. But he cautioned that more work would be needed to improve control of individual robots and track their location.

"It will still be a very long time before they can use them in the body," Gracias said.

The robots are able to move because electricity has a different effect on the two kinds of metal in each leg. The platinum expands while the titanium remains rigid, causing the legs to bend. The front and back legs are alternately contracted or relaxed to generate the robot's gait, Miskin said.

He said the research reminded him of his childhood, when he would look at droplets of water through a microscope, marveling at the range of microorganisms.

"There is this alien, bizarre universe that we know exists in drops of water, in our blood, all over," he said. "We can now go into that world."

Future research will involve developing wireless sensors so the robots can transmit information on vital signs from a patient, such as levels of neuronal activity in the spinal cord, Miskin said. The robots are small enough that they can be injected with a syringe. He also plans to study the best way to retrieve them, perhaps with magnets.

The bots also could be used in non-biological applications. Miskin said a colleague is looking into ways they could be used to improve the performance of rechargeable batteries.

"They could live in your lithium-ion battery, looking for electrical shorts and eating them up so your battery lives longer," he said.

As for the submarine in Fantastic Voyage, Miskin was unable to find a direct mention of its size. But in promotional materials from the movie, it is shown alongside red blood cells, allowing Miskin to estimate that the fictional vessel was about 60 microns in length. Miskin's real-life robots are 70 microns across.

For comparison, human hairs are typically 30 to 100 microns thick. And a standard computer-screen pixel is 250 to 280 microns across.

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