Researchers develop smart micro-robots that can adapt to their surroundings

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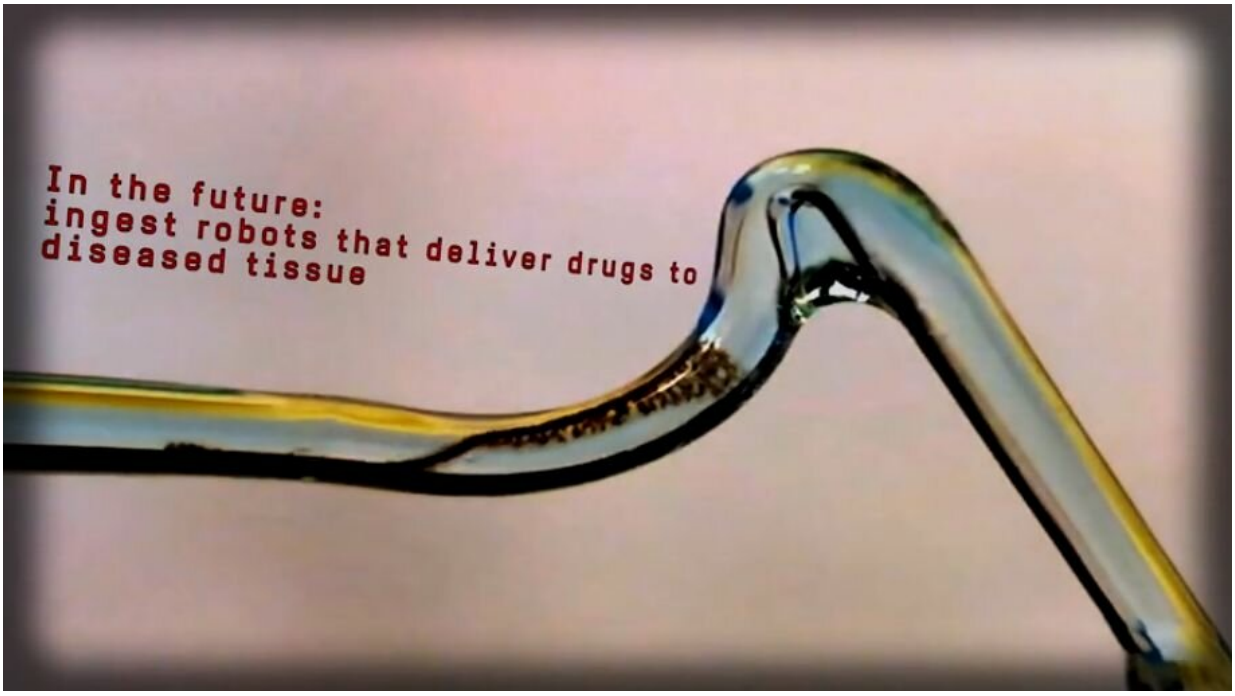

One day, hospital patients might be able to ingest tiny robots that deliver drugs directly to diseased tissue, thanks to research being carried out at EPFL and ETH Zurich.

A group of scientists led by Selman Sakar at EPFL and Bradley Nelson at ETH Zurich drew inspiration from bacteria to design smart, highly

flexible biocompatible micro-robots. Because these devices are able to swim through fluids and modify their shape when needed, they can pass through narrow blood vessels and intricate systems without compromising on speed or maneuverability. They are made of hydrogel nanocomposites that contain magnetic nanoparticles, allowing them to be controlled via an electromagnetic field.

In an article appearing in *Science Advances*, the scientists describe a method for programming the robot's shape so that it can easily travel through fluids that are dense, viscous or moving at rapid speeds.

Embodied intelligence

Fabricating miniaturized robots presents a host of challenges, which the scientists addressed using an origami-based folding method. Their novel locomotion strategy employs embodied intelligence, which is an alternative to the classical computation paradigm that is performed by embedded electronic systems. "Our robots have a special composition and structure that allows them to adapt to the characteristics of the fluid they are moving through. For instance, if they encounter a change in viscosity or osmotic concentration, they modify their shape to maintain their speed and maneuverability without losing control of the direction of motion," says Sakar.

These deformations can be programmed in advance so as to maximize performance without the use of cumbersome sensors or actuators. The robots can be either controlled using an electromagnetic field or left to navigate on their own through cavities by utilizing fluid flow. Either way, they will automatically morph into the most efficient shape.

"Nature has evolved a multitude of microorganisms that change shape as their environmental conditions change. This basic principle inspired our micro-robot design. The key challenge for us was to develop the physics

that describe the types of changes we were interested in, and then to integrate this with new fabrication technologies," says Nelson. In addition to offering enhanced effectiveness, these miniaturized soft robots can also be manufactured easily at a reasonable cost. For now, the research team is working on improving the performance for swimming through complex fluids like those found in the human body.

More information: "Adaptive locomotion of artificial microswimmers" *Science Advances* (2019). advances.sciencemag.org/content/5/1/eaau1532

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