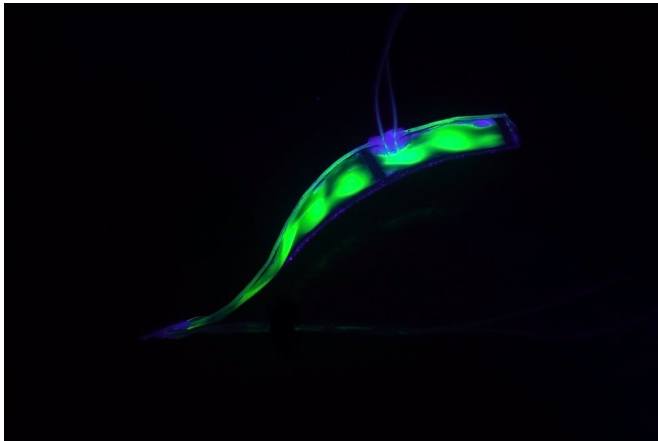


Transparent eel-like soft robot can swim silently underwater

25 April 2018



The conductive chambers inside the robot's artificial muscles can be loaded with fluorescent dye (as shown in the video accompanying the study and this release). In the future, the fluorescence could be used as a kind of signaling system. Credit: University of California San Diego

An innovative, eel-like robot developed by engineers and marine biologists at the University of California can swim silently in salt water without an electric motor. Instead, the robot uses artificial muscles filled with water to propel itself. The foot-long robot, which is connected to an electronics board that remains on the surface, is also virtually transparent.

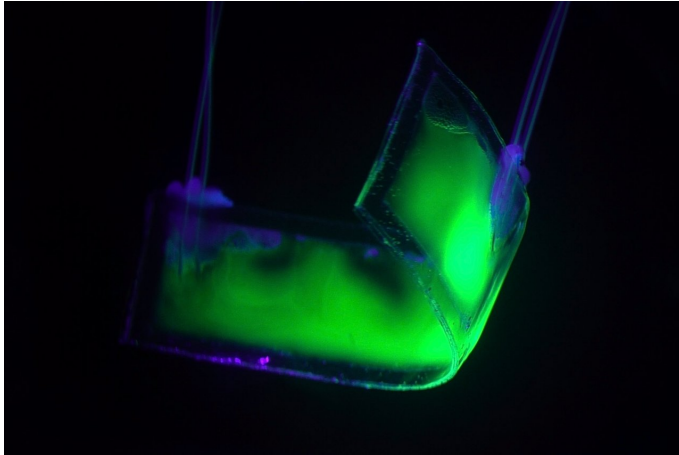
The team, which includes researchers from UC San Diego and UC Berkeley, details their work in the April 25 issue of *Science Robotics*. Researchers say the bot is an important step toward a future when soft robots can swim in the ocean alongside fish and invertebrates without disturbing or harming them. Today, most underwater vehicles designed to observe [marine life](#) are rigid and submarine-like and powered by electric motors with noisy propellers.

"Instead of propellers, our robot uses soft artificial muscles to move like an eel underwater without making any sound," said Caleb Christianson, a Ph.D. student at the Jacobs School of Engineering at UC San Diego.

One key innovation was using the salt [water](#) in which the robot swims to help generate the electrical forces that propel it. The bot is equipped with cables that apply voltage to both the salt water surrounding it and to pouches of water inside of its artificial muscles. The robot's electronics then deliver negative charges in the water just outside of the robot and positive charges inside of the robot that activate the muscles. The electrical charges cause the muscles to bend, generating the robot's undulating swimming motion. The charges are located just outside the robot's surface and carry very little current so they are safe for nearby marine life.

"Our biggest breakthrough was the idea of using the environment as part of our design," said Michael T. Tolley, the paper's corresponding author and a professor of mechanical engineering at the Jacobs School at UC San Diego. "There will be more steps to creating an efficient, practical, untethered eel robot, but at this point we have proven that it is possible."

Previously, other research groups had developed robots with similar technology. But to power these robots, engineers were using materials that need to be held in constant tension inside semi-rigid frames. The *Science Robotics* study shows that the frames are not necessary.



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Next steps also include improving the robot's reliability and its geometry. Researchers need to improve ballast, equipping the robot with weights so that it can dive deeper. For now, engineers have improvised ballast weights with a range of objects, such as magnets. In future work, researchers envision building a head for their eel [robot](#) to house a suite of sensors.

More information: C. Christianson et al., "Translucent soft robots driven by frameless fluid electrode dielectric elastomer actuators," *Science Robotics* (2018). [robotics.sciencemag.org/lookup.../scirobotics.aat1893](https://robotics.sciencemag.org/lookup/.../scirobotics.aat1893)

"This is in a way the softest robot to be developed for underwater exploration," Tolley said.

Provided by University of California - San Diego



Researchers tested the robot in tanks at the Birch Aquarium at the Scripps Institution of Oceanography at UC San Diego. Credit: University of California San Diego

The robot was tested inside [salt-water](#) tanks filled with jelly fish, coral and fish at the Birch Aquarium at the Scripps Institution of Oceanography at UC San Diego and in Tolley's lab.

The conductive chambers inside the robot's [artificial muscles](#) can be loaded with fluorescent dye (as shown in the video accompanying the study and

APA citation: Transparent eel-like soft robot can swim silently underwater (2018, April 25) retrieved 21 October 2021 from <https://techxplore.com/news/2018-04-transparent-eel-like-soft-robot-silently.html>

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