Mini-robots modeled on insects may be smallest, lightest, fastest ever developed

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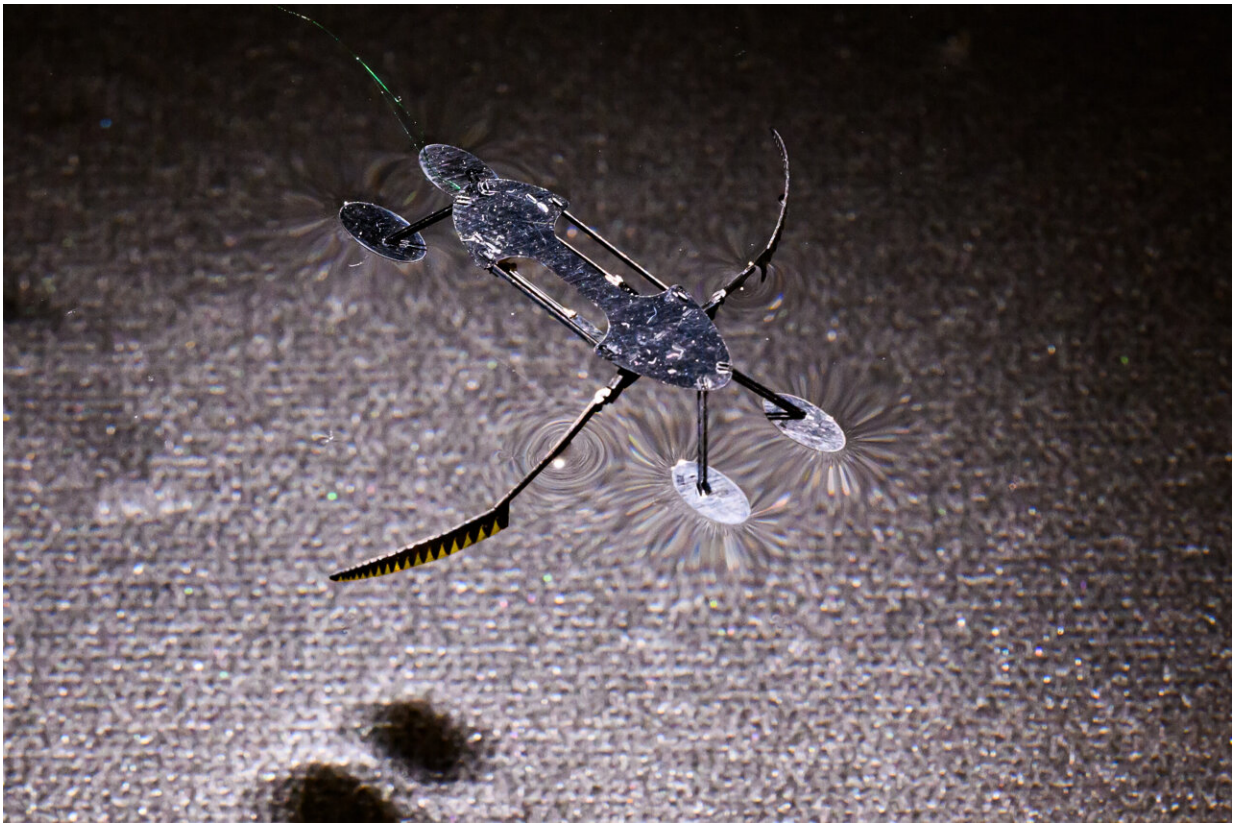

A water skimmer robot created by WSU scientists. Credit: WSU Photo Services

Two insect-like robots, a mini-bug and a water strider, developed at Washington State University, are the smallest, lightest and fastest fully functional micro-robots ever known to be created.

Such miniature robots could someday be used for work in areas such as artificial pollination, search and rescue, environmental monitoring, micro-fabrication or robotic-assisted surgery. Reporting on their work in the proceedings of the IEEE Robotics and Automation Society's International Conference on Intelligent Robots and Systems, the mini-bug weighs in at eight milligrams while the water strider weighs 55 milligrams. Both can move at about six millimeters a second.

"That is fast compared to other micro-robots at this scale, although it still lags behind their biological relatives," said Conor Trygstad, a Ph.D. student in the School of Mechanical and Materials Engineering and lead author on the work. An ant typically weighs up to five milligrams and can move at almost a meter per second.

The key to the tiny robots is their tiny actuators that make the robots move. Trygstad used a new fabrication technique to miniaturize the actuator down to less than a milligram, the smallest ever known to have been made.

"The actuators are the smallest and fastest ever developed for micro-robotics," said Néstor O. Pérez-Arancibia, Flaherty Associate Professor in Engineering at WSU's School of Mechanical and Materials Engineering who led the project.

The actuator uses a material called a shape memory alloy that is able to change shapes when it's heated. It is called 'shape memory' because it remembers and then returns to its original shape. Unlike a typical motor that would move a robot, these alloys don't have any moving parts or spinning components.

A WSU created robot is placed next to a quarter to illustrate its size. Credit: WSU

"They're very mechanically sound," said Trygstad. "The development of the very lightweight actuator opens up new realms in micro-robotics."

Shape memory alloys are not generally used for large-scale robotic movement because they are too slow. In the case of the WSU robots, however, the actuators are made of two tiny shape memory alloy wires that are 1/1000 of an inch in diameter. With a small amount of current, the wires can be heated up and cooled easily, allowing the robots to flap their fins or move their feet at up to 40 times per second. In preliminary tests, the actuator was also able to lift more than 150 times its own weight.

Compared to other technologies used to make robots move, the SMA technology also requires only a very small amount of electricity or heat to make them move.

"The SMA system requires a lot less sophisticated systems to power them," said Trygstad.

Trygstad, an avid fly fisherman, has long observed water striders and would like to study their movements further. While the WSU water strider robot makes a flat flapping motion to move, the natural insect makes a more efficient rowing motion with its legs, which is one of the reasons that the real thing can move much faster.

The researchers would like to copy another insect and develop a water strider-type robot that can move across the top of the water surface as well as just under it. They are also working on using tiny batteries or catalytic combustion to make their robots fully autonomous and untethered from a power supply.

More information: Conor K. Trygstad et al, A New 1-mg Fast Unimorph SMA-Based Actuator for Microrobotics, *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)* (2023). DOI: 10.1109/IROS55552.2023.10342518

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