A polyamide-based soft jellyfish robot actuated by a shape memory alloy

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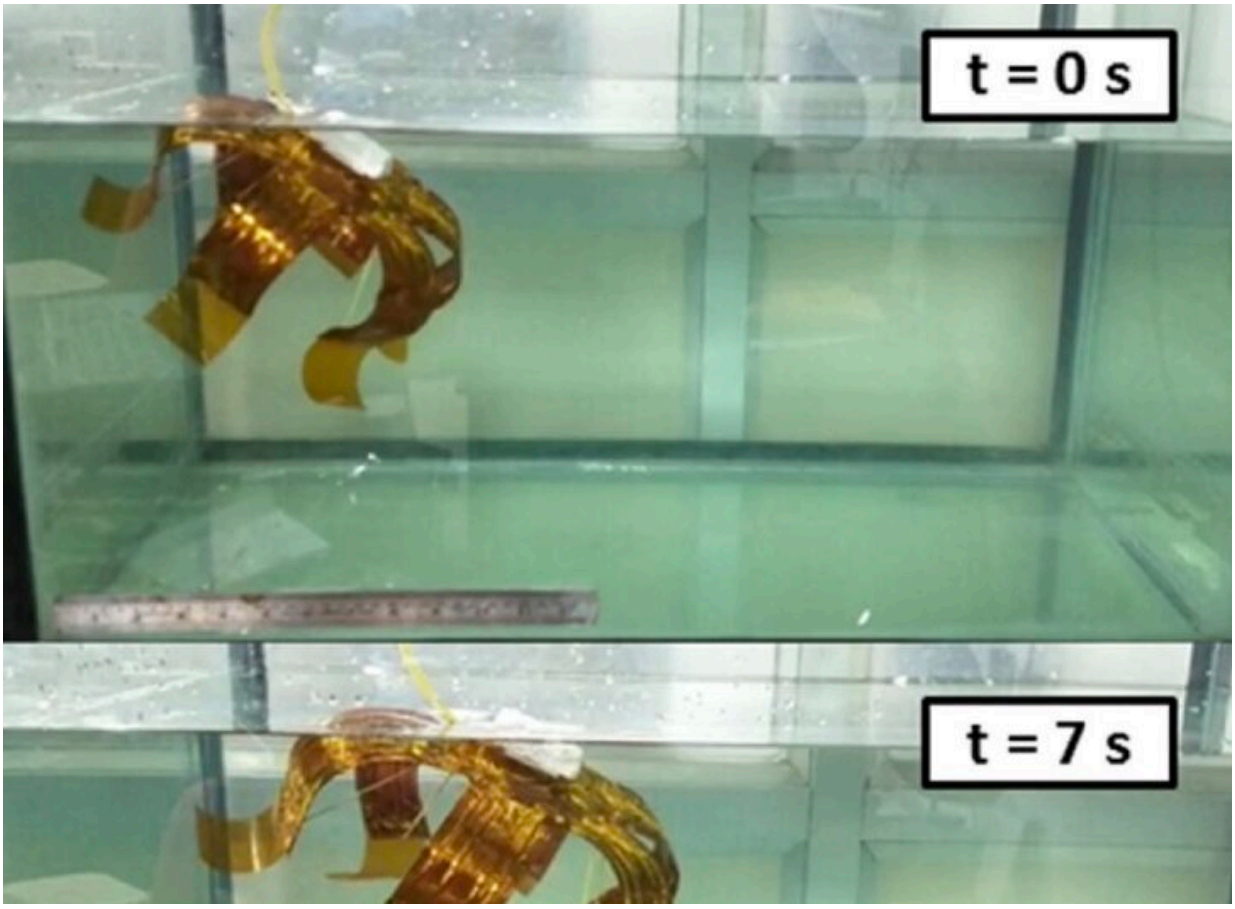

The jellyfish robot developed by the researchers. Credit: Muralidharan et al

In recent decades, roboticists have been developing increasingly sophisticated robots inspired by nature and living organisms. By

realistically emulating biological processes and animal behaviors, these robots can often navigate different environments and tackle real-world problems in highly effective ways.

A research team at the Indian Institute of Technology Indore and the Indian Institute of Technology Jodhpur recently developed a new bio-inspired robot that looks and moves like a jellyfish. This robot, presented in the *International Journal of Intelligent Robots and Applications*, could be used to remotely monitor marine life or carry out other missions underwater.

"A novel flexible polyimide-based soft jellyfish robot actuated by shape memory alloy [SMA] was fabricated and the pulse and recovery process of the jellyfish has been mimicked," Muralidharan, Saini and their colleagues wrote in their paper. "The existing SMA wire-embedded tentacle fabrication technique is a time-consuming and human-tiring process. The proposed structure is novel, cost-effective, and easy to fabricate with very less time consumption compared to conventional mold-based methods."

To create their robot, Muralidharan, Saini and their colleagues first cut 75 μm-thick sheets of Kapton polyamide (i.e., a polyamide-based tape) into a symmetric structure that resembles the body of a jellyfish, with a diameter of 25cm. They then punched holes in this structure at specific positions where they would later insert SMA wires.

SMAs are metals with an interesting property, namely that of returning to their original shape in response to heat after being deformed. For their robot, the researchers used an SMA called nitinol, which is commonly used to create devices, cable connectors, and other electronic components.

Nitinol was inserted in the holes previously punched in the jellyfish-like

structure and an additional piece of polyamide tape was pasted on top of the robot's body to fix the wire in place. The researchers then used rubber strings to connect the end of each tentacle to the center of the robot's body.

"The behavior of the proposed jellyfish structure has been investigated with varying SMA wire diameters and frequencies," Muralidharan, Saini and their colleagues wrote in their paper. "The jellyfish tentacle displacement and velocity during mimicking were measured. The temperature modeling of SMA embedded structure and deflection modeling using beam bending theory has been performed. In addition, a preliminary simulation of the jellyfish mimicking has been carried out in Ansys Fluent and the thrust force has been evaluated."

The jellyfish-inspired robot created by this team of researchers is soft, flexible and very light, weighing only 45g. It is also based on affordable, easily sourced materials and could be easily fabricated on a larger scale. In initial tests, a prototype of the robot performed remarkably well, effectively swimming horizontally at a speed of 10 mm/s and vertically at 0.2 mm/s.

In the future, this new robot could be improved further, tailored for specific applications and commercialized. This could help to efficiently tackle numerous real-world problems that entail navigating and/or monitoring underwater environments.

"The results show that the proposed method can be successfully applied to mimic jellyfish locomotion and extended to underwater applications," the researchers wrote. "The initial prototype has been developed with an onboard camera module and sonar sensor for object detection application with a watertight PDMS bell structure."

More information: M. Muralidharan et al, Bio-inspired soft jellyfish

robot: a novel polyimide-based structure actuated by shape memory alloy, *International Journal of Intelligent Robotics and Applications* (2023). DOI: 10.1007/s41315-023-00291-1