Deployable structures could assist rovers, robots, and spacecraft (w/ Video)

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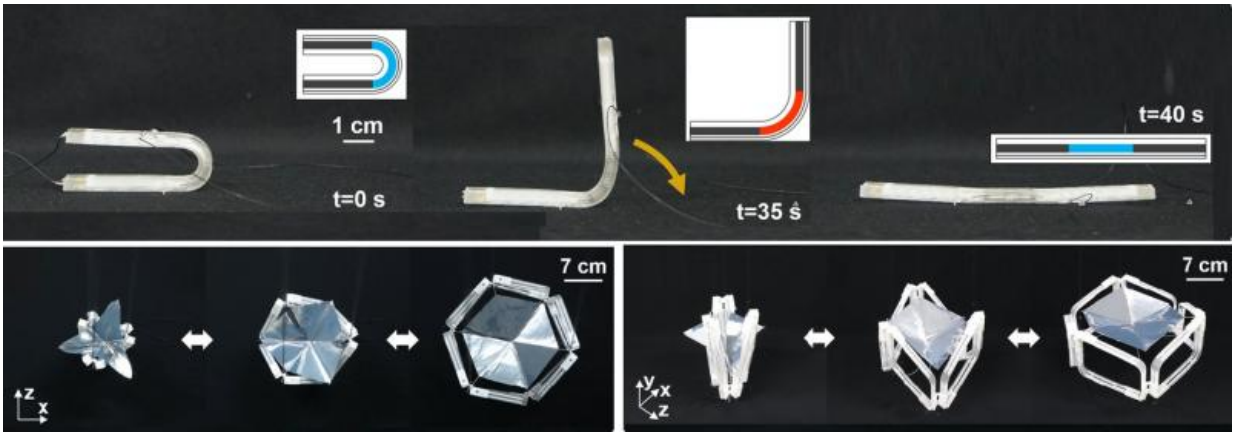

(Top) Smart hinges and (bottom) deployable mirror structures made with the hinges. Credit: Wang, et al. 2016 Nature Scientific Reports

Researchers have fabricated hinges made of smart materials that can open or close when a small electric current is applied. By attaching these hinges to plastic modules of various shapes, the researchers showed that it's possible to build a wide variety of deployable structures that could have applications in the space industry, robotics, and architecture.

The researchers, Wei Wang, Hugo Rodrigue, and Sung-Hoon Ahn at Seoul National University have published a paper on the deployable structures in a recent issue of *Scientific Reports*.

The new hinges look and act very differently than typical hard metal hinges, like those on a door. The new hinges are lightweight and made of soft, flexible phase change materials. Despite the soft appearance, however, they have a high load-bearing capacity due to an embedded rigid structure. The hinges move when 1 amp of electric current is applied to a wire embedded within them. The current changes the hinge material's phase from a solid to liquid-like state, decreasing its stiffness and causing it to open over the course of several seconds. Once the current is turned off, the hinge cools down and maintains its new shape until a new current is applied to collapse the structure back into its compact form.

To demonstrate the potential applications, the researchers used the hinges as linkages to construct a variety of modules, which could then be assembled into larger, more complex modules. When the hinges are closed, the structure sits in a compact, folded state and occupies little space. When the hinges are opened, the entire structure "pops up" into a much larger, load-bearing structure.

One of the structures the researchers built is a deployable mirror for rovers. Rovers use solar power as their main source of power, but these solar systems require constant exposure to sunlight. Sometimes rovers explore dark caves, cutting off this exposure. The idea is that the rover could deploy the mirror just outside the cave before going in, and the mirror could reflect sunlight into the cave onto the rover's solar panels, ensuring that the rover has uninterrupted power.

Besides rovers, the structures could also have applications for rescue robotics and architecture.

"The main advantage of the deployable structures is their volumetric change from their pre-deployed stage where volume is small," Ahn told Phys.org. "For rescue robots made of deployable structures, their small

volume makes delivery via small holes or cracks in damaged buildings or structures possible. For architecture, the smart deployable structures can be used as a small-scale responsive building skin system that can respond to the dynamic environmental conditions to regulate internal conditions, such as light and heat in a habitable space over different periods of time by exhibiting states of motion and dynamism."

The researchers' future plans include testing the lifetimes of the deployable structures, improving the precision of the deployment process, designing new deployable structures with curved shapes, and possibly integrating sensors into the hinge material.

More information: Wei Wang, Hugo Rodrigue, and Sung-Hoon Ahn. "Deployable Soft Composite Structures." *Scientific Reports*. DOI: 10.1038/srep20869