Gumby-like flexible robot crawls in tight spaces (w/ video)

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Harvard scientists have built a new type of flexible robot that is limber enough to wiggle and worm through tight spaces.

It's the latest prototype in the growing field of soft-bodied robots. Researchers are increasingly drawing inspiration from nature to create machines that are more bendable and versatile than those made of metal.

The Harvard team, led by chemist George M. Whitesides, borrowed from squids, starfish and other animals without hard skeletons to fashion

a small, four-legged rubber robot that calls to mind the clay animation character Gumby.

In recent years, scientists have been tinkering with squishy — sometimes odd-looking — robots designed to squeeze through hard-to-reach cracks after a disaster like an earthquake or navigate rough terrain in the battlefield.

"The unique ability for soft robots to deform allows them to go places that traditional rigid-body robots cannot," Matthew Walter, a roboticist at the Massachusetts Institute of Technology, said in an email.

A team from Tufts University earlier this year showed off a 4-inch caterpillar-shaped robot made of silicone rubber that can curl into a ball and propel itself forward.

The Harvard project, funded by the Pentagon's research arm, was described online Monday in the journal *Proceedings of the National Academy of Sciences.*

The new robot, which took two months to construct, is 5 inches long. Its four legs can be separately controlled by pumping air into the limbs, either manually or via computer. This gives the robot a range of motions including crawling and slithering.

The researchers tested the robot's flexibility by having it squirm underneath a pane of glass just three-quarters of an inch from the surface.

Scientists maneuvered the robot through the tiny gap 15 times using a combination of movements. In most cases, it took less than a minute to get from side to side.

Researchers eventually want to improve the robot's speed, but were pleased that it did not break from constant inflation and deflation.

"It was tough enough to survive," said Harvard postdoctoral fellow Robert Shepherd, adding that the robot can traverse on a variety of surfaces including felt cloth, gravel, mud and even Jell-O.

There were drawbacks. The robot is tethered to an external power source and scientists need to find a way to integrate the source before it can be deployed in the real world.

"There are many challenges to actively moving soft robots and no easy solutions," Tufts neurobiologist Barry Trimmer, who worked on the caterpillar robot, said in an email.

Robotics researcher Carmel Majidi, who heads the Soft Machines Lab at Carnegie Mellon University, said the latest robot is innovative even as it builds on previous work.

"It's a simple concept, but they're getting lifelike biological motions," he said.

More information: Multigait soft robot: Published online before print November 28, 2011, doi: 10.1073/pnas.1116564108

Abstract
This manuscript describes a unique class of locomotive robot: A soft robot, composed exclusively of soft materials (elastomeric polymers), which is inspired by animals (e.g., squid, starfish, worms) that do not have hard internal skeletons. Soft lithography was used to fabricate a pneumatically actuated robot capable of sophisticated locomotion (e.g., fluid movement of limbs and multiple gaits). This robot is quadrupedal; it uses no sensors, only five actuators, and a simple pneumatic valving

system that operates at low pressures (