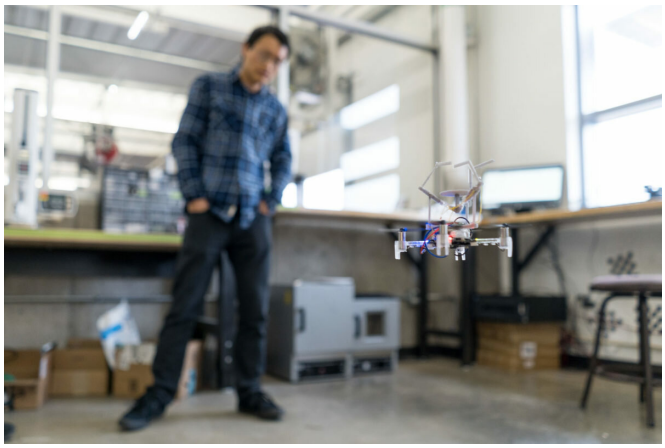
These robots are small, shape-shifting, and they adapt to their surroundings

6 March 2019, by Anne Manning



Assistant Professor Jianguo Zhao with one of his lab's flying robots. Credit: Colorado State University

With its low ceiling draped in soft, green netting, Jianguo Zhao's lab at the Colorado State University Powerhouse Energy Campus is hard to miss. Watch the lab's walking, grasping, flying, perching, shape-shifting robots in motion, and the reason for the netting becomes all too clear.

Fortunately for passers-by, most of the machines that zip around the lab fit in one hand and cause hardly a ruckus. Beyond being small, these robots have something else in common: they're designed to change shape in response to their environment. That's the unifying theme of this lively engineering lab: adaptive robotics.

"We could call them transformers," says undergraduate researcher Brandon Tighe, grinning. "But if we did that, we'd probably have kids lined up at the door." Which wouldn't necessarily be a bad thing – the engineers are happy to share what they're working on, after all, and brought some of their robots to the Little Shop of Physics Open House last month. But the day-to-day grind of designing and testing robots is decidedly less glamorous than the movies would have you believe.

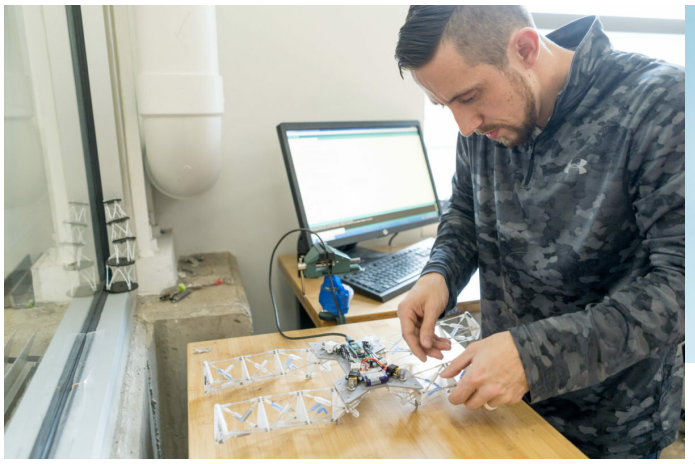
Changing on the fly

The goal of Zhao's lab is to create small, lightweight robots that can reconfigure themselves in response to a need. "In general, if you have a robot, its mechanical structure is fixed," says Zhao, an assistant professor in the Department of Mechanical Engineering. "If we can change the mechanical structure on the fly, without redesigning the robot, this is pretty useful, especially if the robot is very small … I don't think many people are trying to do that."

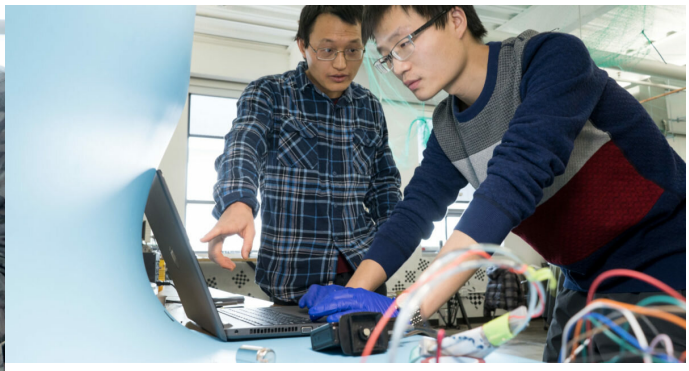
Zhao's mind goes to military applications, environmental monitoring, or search-and-rescue operations. Think small, wirelessly tethered robots that could be deployed in a disaster zone, nimbly skirting obstacles and changing the shape of their joints, without expending energy, to withstand various terrains.

Federal support

Zhao's efforts are supported by several federal grants. Among them is $500,000 from the National Science Foundation that he shares with Bo Cheng at Penn State to develop flying robots that can perch like an insect. Graduate student Haijie Zhang is spearheading that effort. Last year, Zhao also received NSF support for a shape-morphing robot with legs that can perform different locomotions – like a frog uses its legs to swim as well as hop. This scheme would eventually be applied to an amphibious robot with legs that could seamlessly morph to swim and walk.



Undergraduate researcher Brandon Tighe with a reconfigurable robot designed to use its legs to both walk and grasp. Credit: Colorado State University



Assistant Professor Jianguo Zhao, left, and graduate student Jiefeng Sun in the Adaptive Robotics Lab. Credit: Colorado State University

Provided by Colorado State University

Visitors to the lab will see these and other prototypes in action. For instance, grad student Jiefeng Sun is designing a robotic gripper that can alternately soften and stiffen its surface, aided only by artificial muscles made from household sewing threads

Over in another corner, Tighe demonstrates his "baby": A four-legged walking beast whose front two legs he's trying to convert into limbs that can grasp an object.

Such works in progress get Zhao up and out of bed every morning, much like when he first got hooked on robotics as an undergraduate in China.

"The best thing about our lab is working together on difficult problems," he says. "When we are building robots, you can see the results, but it takes trial and error. You cannot expect it to work the very first time."

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