Robot-ants that can jump, communicate with each other and work together

July 10 2019

Tribot robots have five locomotion strategies. Credit: Zhenishbek Zhakypov / EPFL

Individually, ants have only so much strength and intelligence, but as a colony they can use complex strategies to complete sophisticated tasks and evade larger predators.

At EPFL, robotics researchers in Professor Jamie Paik's Laboratory have reproduced this phenomenon, developing tiny robots that display minimal physical intelligence on an individual level but that are able to communicate and act collectively. Despite being simple in design and weighing only 10 grams, each robot has multiple locomotion modes to navigate any type of surface. Collectively, they can quickly detect and overcome obstacles and move objects much larger and heavier than themselves. The related research has been published in *Nature*.

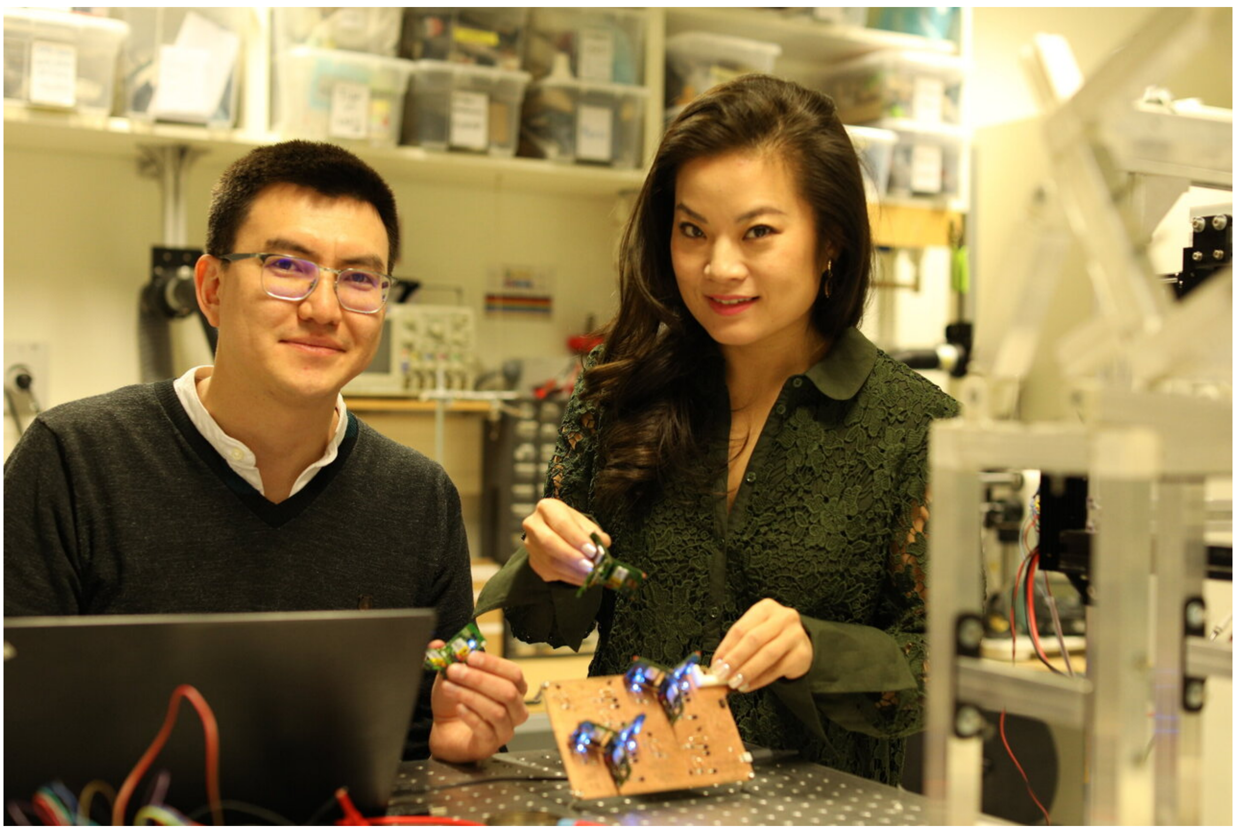
Robots inspired by trap-jaw ants

These three-legged, T-shaped origami robots are called Tribots. They can be assembled in only a few minutes by folding a stack of thin, multi-material sheets, making them suitable for mass production. Completely autonomous and untethered, Tribots are equipped with infrared and proximity sensors for detection and communication purposes. They could accommodate even more sensors depending on the application.

"Their movements are modeled on those of Odontomachus ants. These insects normally crawl, but to escape a predator, they snap their powerful jaws together to jump from leaf to leaf," says Zhenishbek Zhakypov, the first author. The Tribots replicate this catapult mechanism through an elegant origami design that combines multiple shape-memory alloy actuators. As a result, a single robot can produce five distinct locomotion gaits: vertical jumping, horizontal jumping, somersaulting to clear obstacles, walking on textured terrain and crawling on flat surfaces—just like these creatively resilient ants.

Roles: Leader, worker and explorer

Despite having the same anatomy, each robot is assigned a specific role depending on the situation. 'Explorers' detect physical obstacles in their path, such as objects, valleys and mountains. After detecting an obstacle, they inform the rest of the group. Then, the 'leader' gives the instructions. The 'workers,' meanwhile, pool their strength to move objects. "Each Tribot, just like Odontomachus ants, can have different roles. However, they can also take on new roles instantaneously when faced with a new mission or an unknown environment, or even when other members get lost. This goes beyond what real ants can do," says Paik.



Zhenishbek Zhakypov and Jamie Paik in the lab, holding some tribots. Credit: Marc Delachaux / EPFL

Future applications

In practical situations, such as an emergency search mission, Tribots could be deployed en masse. And thanks to their multi-locomotive and multi-agent communication capabilities, they could locate a target quickly over a large surface without relying on GPS or visual feedback. "Since they can be manufactured and deployed in large numbers, having some 'casualties' would not affect the success of the mission," adds Paik."

"With their unique collective intelligence, our tiny robots can demonstrate better adaptability to unknown environments; therefore, for certain missions, they would outperform larger, more powerful robots."

More information: Zhenishbek Zhakypov, Kazuaki Mori, Koh Hosoda and Jamie Paik, Designing Minimal and Scalable Insect-Inspired Multi-Locomotion Millirobots, *Nature*, 10 July 2019. DOI: 10.1038/s41586-019-1388-8 , nature.com/articles/s41586-019-1388-8

Provided by Ecole Polytechnique Federale de Lausanne