Tiny robot flies like a fly

Engineers create first device able to mimic full range of insect flight.

Ron Cowen

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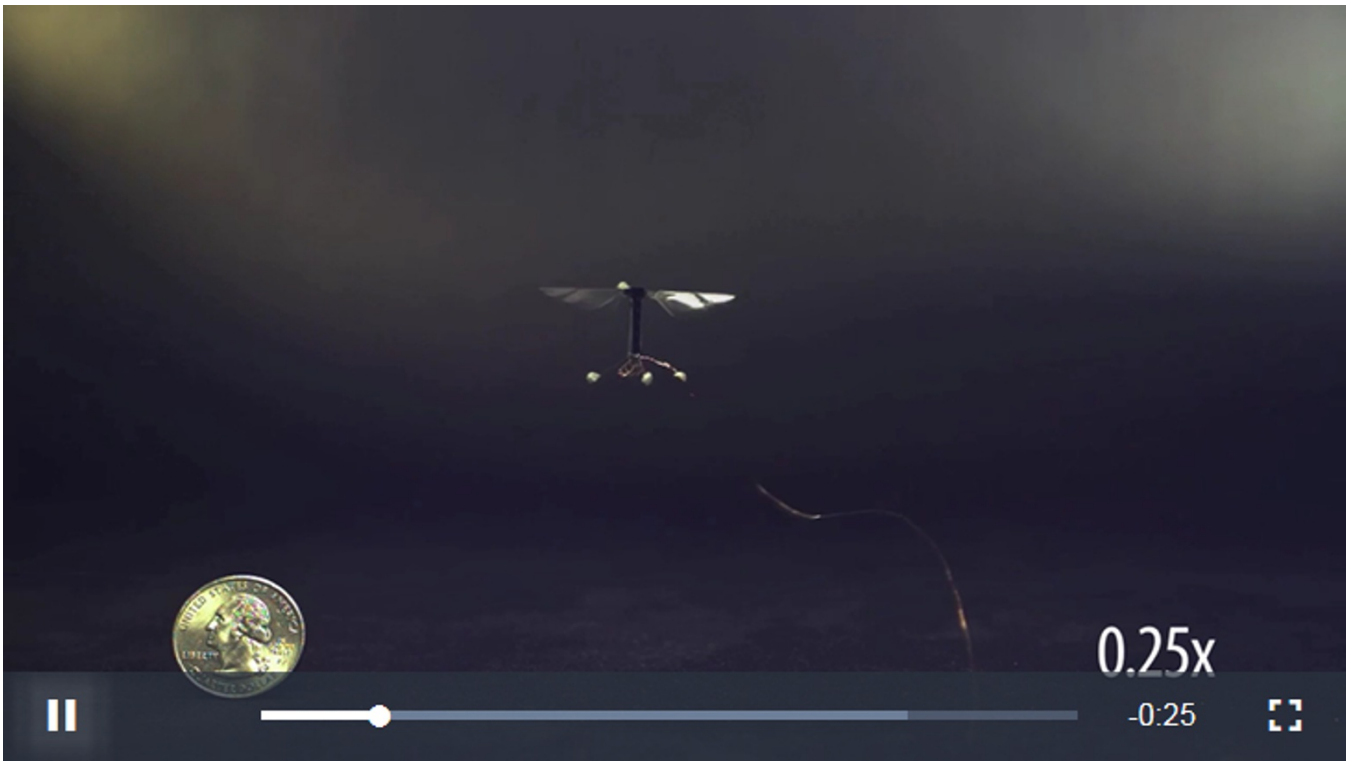

A robot as small as a housefly has managed the delicate task of flying and hovering the way the actual insects do.

“This is a major engineering breakthrough, 15 years in the making,” says electrical engineer Ronald Fearing, who works on robotic flies at the University of California, Berkeley. The device uses layers of ultrathin materials that can make its wings flap 120 times a second, which is on a par with a housefly's flapping rate. This “required tremendous innovation in design and fabrication techniques”, he adds.

The robot's wings are composed of thin polyester films reinforced with carbon fibre ribs and its 'muscles' are made from piezoelectric crystals, which shrink or stretch depending on the voltage applied to them.

Kevin Ma and his colleagues, all based at Harvard University in Cambridge, Massachusetts, describe their design today in *Science*[1].

The tiny components, some of which are just micrometres across, are extremely difficult to make using conventional manufacturing technologies, so the researchers came up with a folding process similar to that used in a pop-up book. They created layers of flat, bendable materials with flexible hinges that enabled the three-dimensional structure to emerge in one fell swoop. “It is easier to make two-dimensional structures and fold them into three dimensions than it is to make three dimensional structures directly,” explains Ma.

Manufacturing marvel

“The ability to manufacture these little flexure joints is going to have implications for a lot of aspects of robotics that have nothing to do with making a robotic fly,” notes Michael Dickinson, a neuroscientist at the University of Washington in Seattle.

The work “will also lead to better understanding of insect flapping wing aerodynamics and control strategies” because it uses an engineering system “that can be more easily modified or controlled than an animal”, Fearing adds.

Weighing in at just 80 milligrams, the tiny drone cannot carry its own power source, so has to stay tethered to the ground. It also relies

on a computer to monitor its motion and adjust its attitude. Still, it is the first robot to deploy a fly's full range of aerial motion, including hovering.

The biggest technical obstacle to independent flight is building a battery that is small enough to be carried by the robotic fly, says Fearing. At present, the smallest batteries with enough power weigh about half a gram — ten times more than what the robotic fly can support. Ma says he believes that the battery obstacle might be overcome in 5-10 years.

If researchers can come up with such a battery, and with lightweight onboard sensors, Ma says that the robots could be useful in applications such as search and rescue missions in collapsed buildings, or as ways to pollinate crops amid dwindling bee populations.

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References

1. Ma, K. Y., Chirarattananon, P., Fuller, S. B. & Wood, R. J. *Science* **340**, 603–607 (2013).