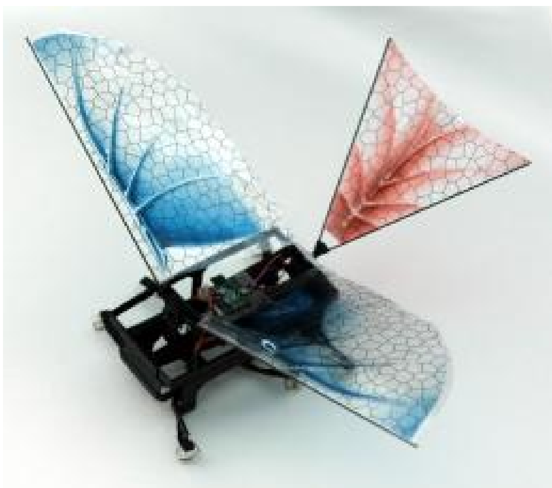
Robotic bug gets wings, sheds light on evolution of flight (w/ video)

October 17 2011



A dynamic hexapedal robot with flapping wings (DASH+Wings) for flapping wings configuration. Image: University of California at Berkeley

(PhysOrg.com) -- A six-legged, 25 gram robot has been fitted with flapping wings in order to gain an insight into the evolution of early birds and insects.

When engineers at the University of California, Berkeley, outfitted a six-legged robotic bug with wings in an effort to improve its mobility, they unexpectedly shed some light on the evolution of flight.

Even though the wings significantly improved the running performance of the 10-centimeter-long robot – called DASH, short for Dynamic

Autonomous Sprawled Hexapod – they found that the extra boost would not have generated enough speed to launch the critter from the ground. The wing flapping also enhanced the aerial performance of the robot, consistent with the hypothesis that flight originated in gliding tree-dwellers.

The research team, led by Ron Fearing, professor of electrical engineering and head of the Biomimetic Millisystems Lab at UC Berkeley, reports its conclusions online Tuesday, Oct. 18, in the peer-reviewed journal *Bioinspiration and Biomimetics*.

Using robot models could play a useful role in studying the origins of flight, particularly since fossil evidence is so limited, the researchers noted.

First unveiled by Fearing and graduate student Paul Birkmeyer in 2009, DASH is a lightweight, speedy robot made of inexpensive, off-the-shelf materials, including compliant fiber board with legs driven by a battery-powered motor. Its small size makes it a candidate for deployment in areas too cramped or dangerous for humans to enter, such as collapsed buildings.

A robot gets its wings

But compared with its biological inspiration, the cockroach, DASH had certain limitations as to where it could scamper. Remaining stable while going over obstacles is fairly tricky for small robots, so the researchers affixed DASH with lateral and tail wings borrowed from a store-bought toy to see if that would help.

"Our overall goal is to give our robots the same all-terrain capabilities that other animals have," said Fearing. "In the real world, there will be situations where flying is a better option than crawling, and other places where flying won't work, such as in confined or crowded spaces. We needed a hybrid running-and-flying robot."

The researchers ran tests on four different configurations of the robotic roach, now called DASH+Wings. The test robots included one with a tail only and another that just had the wing's frames, to determine how the wings impacted locomotion.

With its motorized flapping wings, DASH+Wings' running speed nearly doubled, going from from 0.68 meters per second with legs alone to 1.29 meters per second. The robot could also take on steeper hills, going from an incline angle of 5.6 degrees to 16.9 degrees.

"With wings, we saw improvements in performance almost immediately," said study lead author Kevin Peterson, a Ph.D. student in Fearing's lab. "Not only did the wings make the robot faster and better at steeper inclines, it could now keep itself upright when descending. The wingless version of DASH could survive falls from eight stories tall, but it would sometimes land upside down, and where it landed was partly guided by luck."

The flapping wings improved the lift-drag ratio, helping DASH+Wings land on its feet instead of just plummeting uncontrolled. Once it hit the ground, the robot was able to continue on its way. Wind tunnel experiments showed that it is aerodynamically capable of gliding at an angle up to 24.7 degrees.

Tree-dwellers vs. ground-runners

The engineering team's work caught the attention of animal flight expert Robert Dudley, a UC Berkeley professor of integrative biology, who noted that the most dominant theories on flight evolution have been primarily derived from scant fossil records and theoretical modeling.

He referenced previous computer models suggesting that ground-dwellers, given the right conditions, would need only to triple their running speed in order to build up enough thrust for takeoff. The fact that DASH+Wings could maximally muster a doubling of its running speed suggests that wings do not provide enough of a boost to launch an animal from the ground. This finding is consistent with the theory that flight arose from animals that glided downwards from some height.

"The fossil evidence we do have suggests that the precursors to early birds had long feathers on all four limbs, and a long tail similarly endowed with a lot of feathers, which would mechanically be more beneficial for tree-dwelling gliders than for runners on the ground," said Dudley.

Dudley said that the winged version of DASH is not a perfect model for proto-birds – it has six legs instead of two, and its wings use a sheet of plastic rather than feathers – and thus cannot provide a slam-dunk answer to the question of how flight evolved.

"What the experiments did do was to demonstrate the feasibility of using robot models to test hypotheses of flight origins," he said. "It's the proof of concept that we can actually learn something useful about biological performance through systematic testing of a physical model."

Among other robotic insects being tested in the Biomimetic Millisystems Lab is a winged, bipedal robot called BOLT (Bipedal Ornithopter for Locomotion Transitioning) that more closely resembles the size and aerodynamics of precursors to flying birds and insects.

"It's still notable that adding wings to DASH resulted in marked improvements in its ability to get around," said Fearing. "It shows that flapping wings may provide some advantages evolutionarily, even if it doesn't enable flight."

More information: "A wing assisted running robot and implications for avian flight evolution" K Peterson, P Birkmeyer, R Dudley and R S Fearing 2011 *Bioinspir. Biomim.* 6 046008: iopscience.iop.org/1748-3190/6/4/046008

Provided by University of California - Berkeley

Citation: Robotic bug gets wings, sheds light on evolution of flight (w/ video) (2011, October 17) retrieved 18 April 2024 from https://phys.org/news/2011-10-tree-dwelling-animals.html