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Building Better Flapping Fliers

Baltimore, Md. – Flapping mini-robots that can maneuver in tight spaces could be ideal for search-and-rescue operations – say, in collapsed buildings. However, current versions of such micro-air vehicles are “violently unstable,” says fluid dynamicist Leif Ristroph of New York University. “Without some very good sensory feedback strategies, they quickly spin out of control and tumble from the air.”

Looking for more stable designs, Ristroph, Bin Liu of Brown University, and their colleagues analyzed the behavior of paper “bugs” of a variety of shapes (including cones, pyramids, umbrellas, and saucer-shaped UFOs) flying in a “flapping-flight wind tunnel” – a low-frequency woofer loudspeaker, turned upward and fitted with a metallic cap and a clear cylinder in which bugs fly. When the speaker is turned on, it shakes the air in the cylinder up-and-down, mimicking the effect of active flapping.

Surprisingly, the researchers found that top-heavy designs are the most stable.

“That high center-of-mass is more stable is weird if we’re used to thinking about everyday objects,” Ristroph says. “For example, a wine glass is top-heavy relative to a beer mug and is intuitively more likely to get tipped over. Our bugs, on the other hand, are happiest when their weight is up high.”

“Our experiments suggest that the stability of flying insects is a subtle balancing act that depends on how vortices shoot off of flapping wings,” Ristroph explains. “The basic idea is that these shapes are asymmetric and thus can generate upward force even if they are flapped up-and-down symmetrically. For example, the cone or umbrella ‘grabs’ the air strongly as it moves down and then slices through the air as it moves up and thus generates a net upward force per flapping cycle.”

The findings, he says, could provide a blueprint for building more stable but highly maneuverable insect-sized robots. “We’re currently building some actual free-flying bugs that are inspired by our paper bugs: the idea is that these robots will flap wing-like surfaces and hold themselves up.”

Ristroph discusses the findings in a talk at the *APS Division of Fluid Dynamics Meeting*, which will take place Nov. 20-22, 2011, at the Baltimore Convention Center in the historic waterfront district of Baltimore, Maryland.

The talk, “The importance of being top-heavy: Intrinsic stability of flapping flight,” is at 3:29 p.m. on Sunday, Nov. 20, in Room 309.

Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-001525.pdf

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MORE MEETING INFORMATION
The 64th Annual DFD Meeting is hosted by the Johns Hopkins University, the University of Maryland, the University of Delaware and the George Washington University. Howard University and the U.S. Naval Academy are also participating in the organization of the meeting. It will be held at the Baltimore Convention Center, located in downtown Baltimore, Md. All meeting information, including directions to the Convention Center, is at:
http://www.dfd2011.jhu.edu/index.html

USEFUL LINKS
Main Meeting Web Site: *http://www.dfd2011.jhu.edu/index.html*
Search Abstracts: *http://meeting.aps.org/Meeting/DFD11/Content/2194*
Directions and Maps: *http://www.dfd2011.jhu.edu/venuemaps.html*

PRESS REGISTRATION
Credentialed full-time journalists and professional freelance journalists working on assignment for major publications or media outlets are invited to attend the conference free of charge. If you are a reporter and would like to attend, please contact Charles Blue (cblue@aip.org, 301-209-3091).

SUPPORT DESK FOR REPORTERS
A media-support desk will be located in the exhibit area. Press announcements and other news will be available in the Virtual Press Room (see below).

VIRTUAL PRESS ROOM
The APS Division of Fluid Dynamics Virtual Press Room features news releases, graphics, videos, and other information to aid in covering the meeting on site and remotely. See:
http://www.aps.org/units/dfd/pressroom/index.cfm