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Flight Stabilization with Flapping Wings in Gusty Environments
CHAO ZHANG, LINGXIAO ZHENG, The Johns Hopkins University, TYSON HEDRICK, The University of North Carolina, RAJAT MITTAL, The Johns Hopkins University, FSAG TEAM — Achieving stable flight with flapping wings, is one of the major challenges for designing micro- aerial- vehicles (MAVs) but is part of the natural behavior of flying insects. To better understand how flying insects flyers can stabilize themselves during hovering flight, we use a computational model, which couples the Navier-Stokes equations for the aerodynamics with a six-degree of freedom (NS-6-DOF) flight dynamics model to recreate the free hovering flight of a hawkmoth. The NS-6DOF model indicates that a hovering hawkmoth is open-loop unstable. Examination of the aerodynamic forces and flight dynamics coupled with observations of the animal in the laboratory suggest a bioinspired strategy for close-loop stabilization of the hovering hawkmoth and this strategy is explored using the NS-6DOF insect model. Simulations are conducted both for quiescent and highly "gusty" ambient conditions and the computed response of the "stabilized" animal compared to experimental observations.

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