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Unsteady flow and force control for flies landing upside down on a ceiling KAROLINE MENZE, Villanova University, PAN LIU, BO CHENG, Pennsylvania State University, CHENGYU LI, Villanova University — The process landing upside down on a ceiling (i.e., inverted landing) for a fly is a common, yet complex aerodynamic feat. It is known that these inverted landing maneuvers require a sequence of well-coordinated behavioral modules of the body. However, the wing kinematics of these physical maneuvers remain largely unknown, and the fluid dynamic principles underlying this sophisticated behavior are still out of our grasp. In this work, we turned a high-speed photogrammetry of the inverted landing of a blue bottle fly (Calliphra vomitoria) into a 3D surface reconstruction. The reconstructed data was used to investigate the wing kinematics of a fly during an inverted landing. High fidelity simulations were then carried out in order to understand vortex formation in both near-field and far-field of flapping wings and examine the associated aerodynamic performance. A Cartesian grid based sharp interface immersed boundary solver was used to handle such unsteady flow simulations in all their complexity. Our simulation results of aerodynamic forces indicated that, as the fly approaching the ceiling, it reorients the wing stroke plane more vertically and produces minimum force along the horizontal direction.

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