Abstract Submitted
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Optimization and scaling of aerodynamic performance for a flapping wing in hover[1] ALEXANDER GEHRKE, KAREN MULLENERS, Ecole Polytechnique Federale de Lausanne — We experimentally optimise the pitch angle kinematics of a flapping wing system in hover to maximise the stroke average lift and hovering efficiency with the help of an evolutionary algorithm and in-situ force and torque measurements at the wing root. Additional flow field measurements are conducted to link the vortical flow structures to the aerodynamic performance. The pitch angle profiles yielding maximum average lift have trapezoidal shapes and high average angles of attack. These kinematics create a strong leading edge vortex early in the cycle which enhances the force production. The most efficient pitch angle kinematics resemble sinusoidal evolutions and have lower average angles of attack. The leading edge vortex grows slower and stays close-bound to the wing for the majority of the stroke-cycle. This increases the efficiency by 93% but sacrifices 43% of the lift in the process. We estimate the shear-layer velocity at the leading edge solely from the input kinematics and use it to scale the average and the time-resolved evolution of the circulation and the aerodynamic forces. The experimental data agrees well with the shear-layer velocity prediction, making it a promising metric to quantify and predict the aerodynamic performance of the flapping wing hovering motion.

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