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Aerodynamic Effect for Collision-Free Reactive Navigation of a Small Quadcopter

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***Abstract*—Small aerial vehicles have great potential for applications such as manufacturing, logistics, and wildlife surveys. However, their limited payload capacity and endurance pose significant challenges for onboard sensing and navigation, especially for millimeter- to centimeter-scale flyers. This work offers a sensing and control strategy for a small quadrotor to achieve reactive autonomy, defined as flying and avoiding collisions. This relies on a minimal suite of sensors typically employed for hovering flight only. We analyze and model the aerodynamic interactions between propellers and nearby walls, which are amplified by the robot's ducted propellers. The results are integrated with flight dynamics to enable the robot to estimate wall distance and direction. A flight controller is devised to safely stabilize the robot near a wall. Together, the sensing and control framework allows the robot to react, fly, and avoid collisions without extra sensors or visual-inertial navigation.**