

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

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1 Background

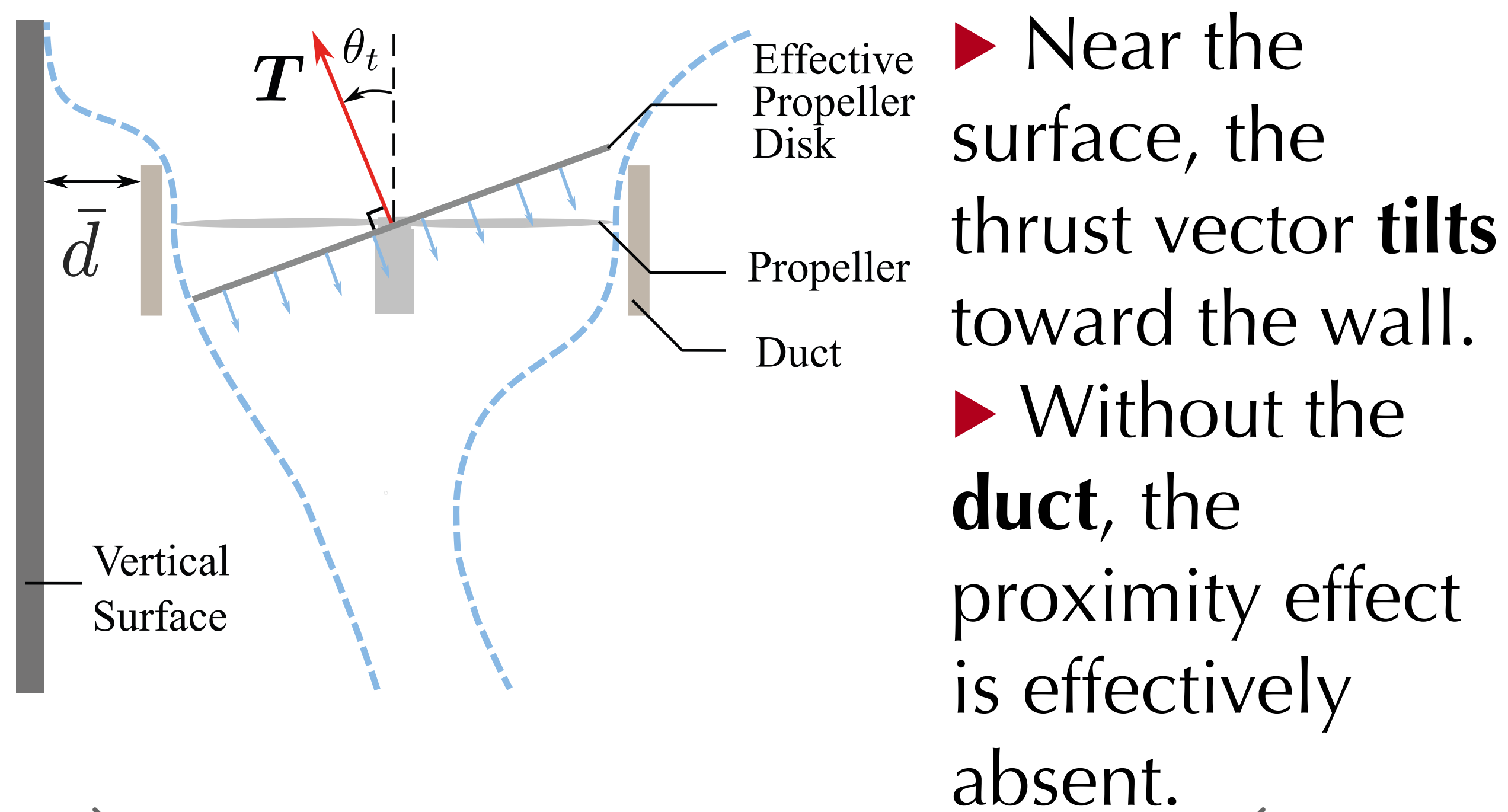
Collision avoidance and mitigation for small aircraft

- ▶ Visual-inertial navigation [1] >> high computational demand
- ▶ Mechanical resilience for impact mitigation [2] >> added weight



3 Changing Propelling Force

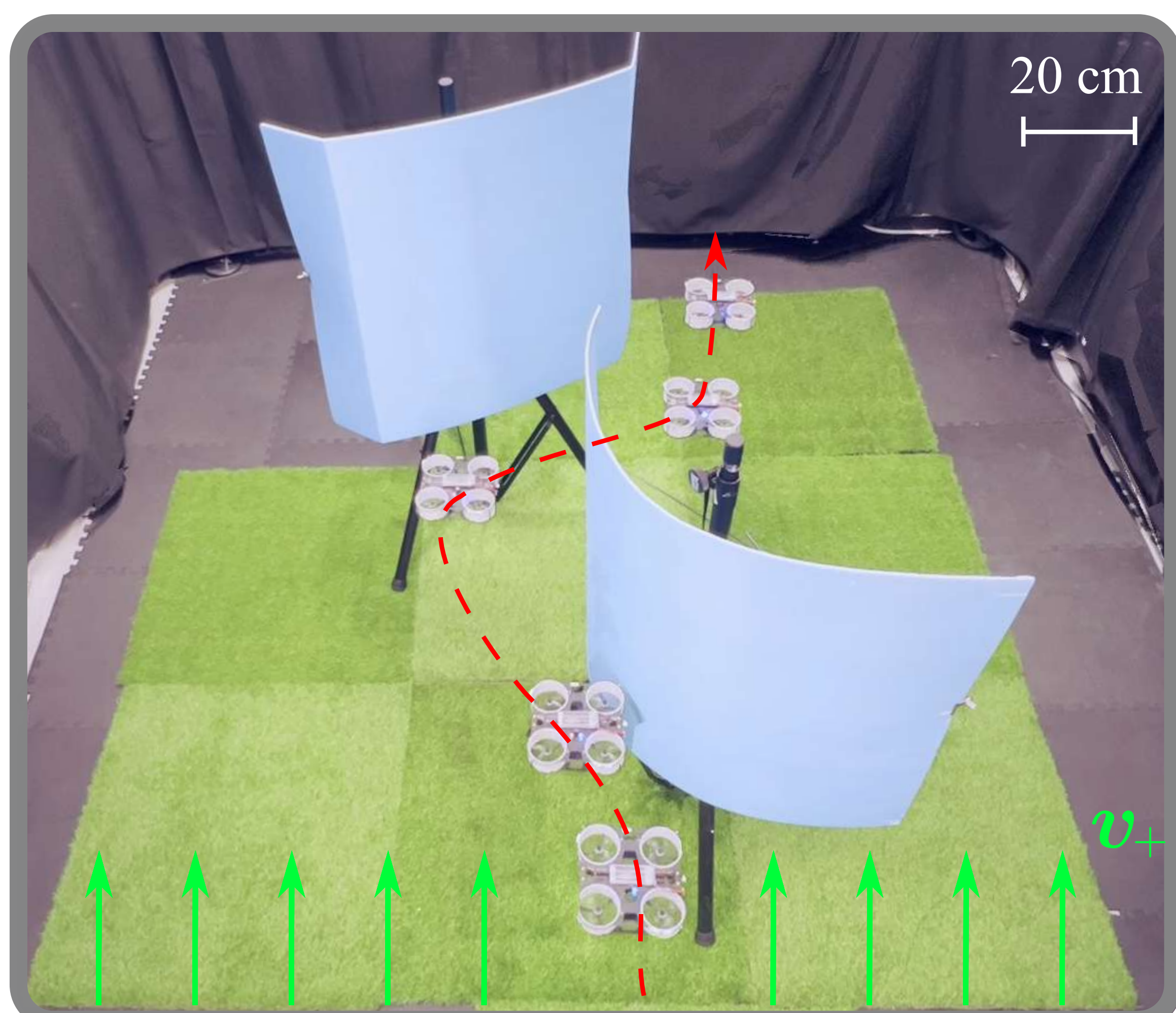
Ducts make a huge difference!



IMU-based EKF Estimation for wall distance and direction

5 Complex Environments

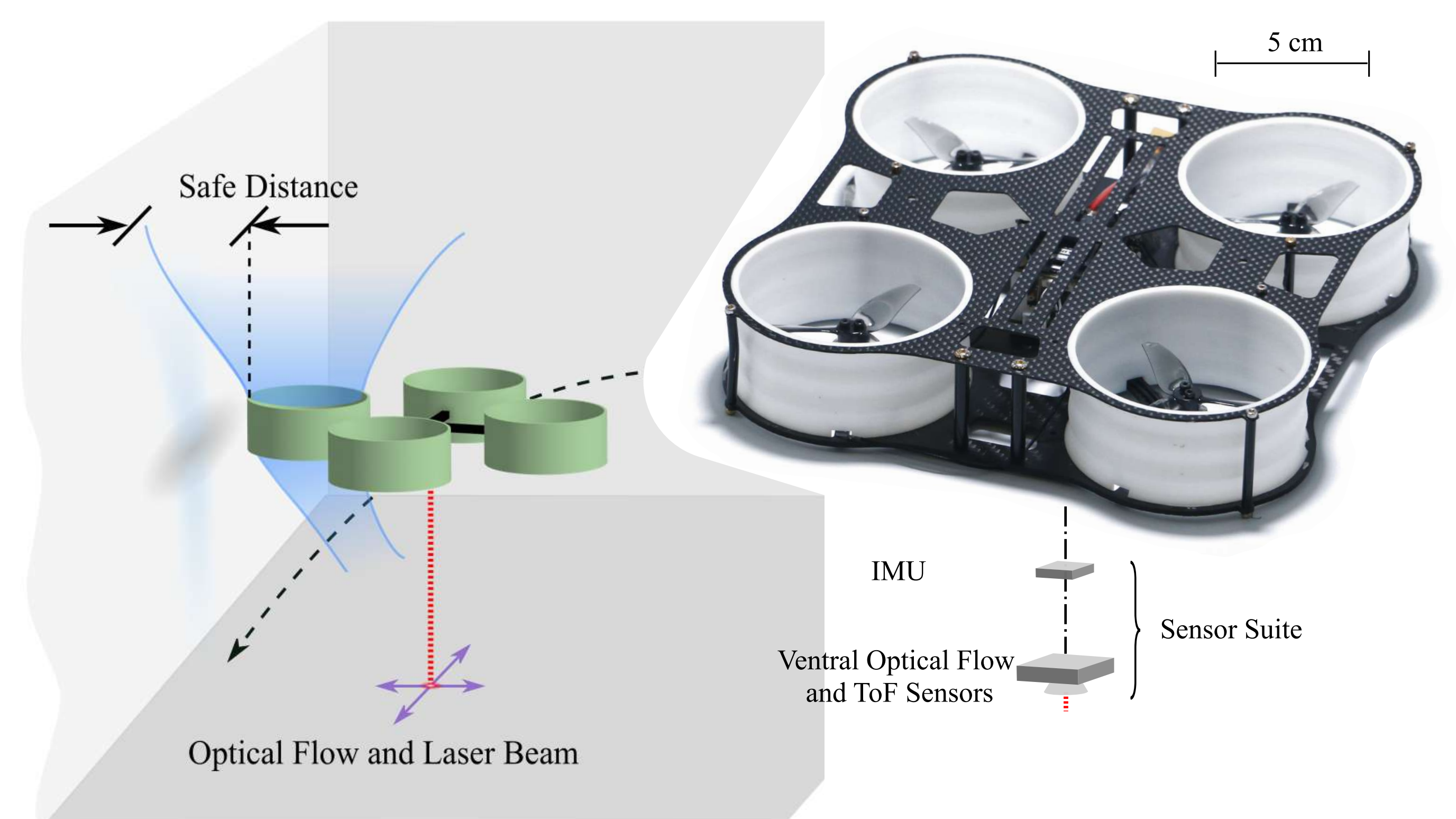
Collision-free reactive navigation



2 Motivation

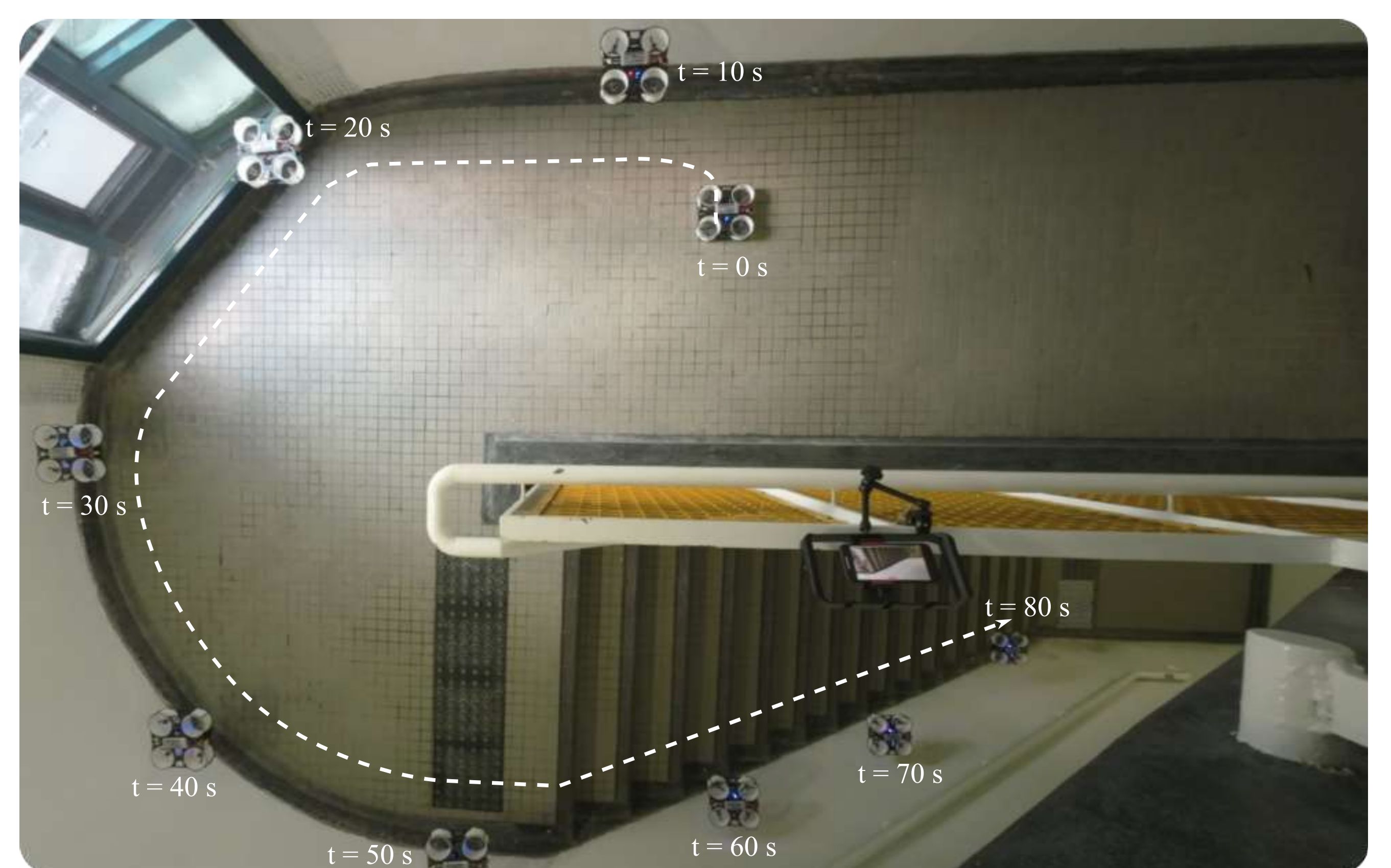
Aerodynamics-based approach [3,4]

- ▶ Can we use **existing sensors** to detect vertical surfaces? (think *ground effects*)



4 Wall Tracking Flight

The robot keeps its distance!



6 References

[1] X. Zhou, X. Wen, Z. Wang, Y. Gao, H. Li, Q. Wang, T. Yang, H. Lu, Y. Cao, C. Xu, and F. Gao, "Swarm of micro flying robots in the wild.", *Science Robotics*, vol. 7, no. 66, 2022

[2] J. Shu and P. Chirarattananon, "A quadrotor with an origami-inspired protective mechanism," *IEEE Robotics and Automation Letters*, vol. 4, no. 4, pp. 3820–3827, 2019.

[3] Y. H. Hsiao and P. Chirarattananon, "Ceiling effects for hybrid aerial-surface locomotion of small rotorcraft," *IEEE/ASME Transactions on Mechatronics*, vol. 24, no. 5, pp. 2316–2327, 2019.

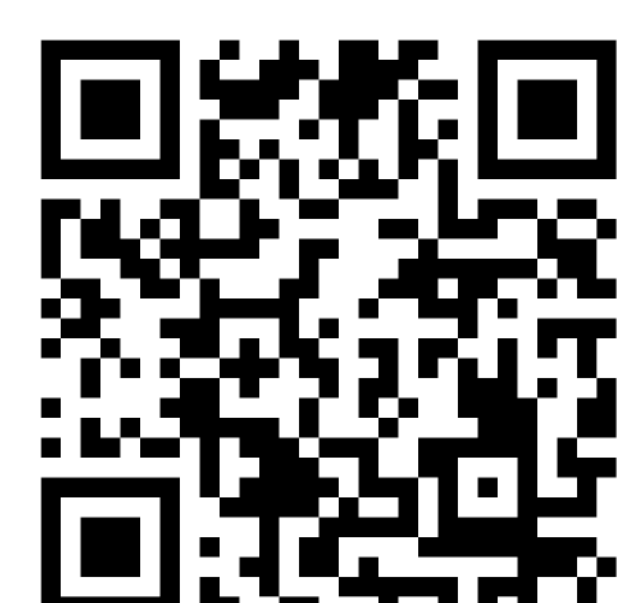
[4] R. Ding, Y.H. Hsiao, H. Jia, S. Bai, and P. Chirarattananon, "Passive wall tracking for a rotorcraft with tilted and ducted propellers using proximity effects." *IEEE Robotics and Automation Letters*, 7(2), pp.1581-1588, 2022.

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Video



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