

Introduction

Problem:

Traversing dense vegetation is crucial for unlocking a wide range of UAV field applications. However, it remains highly challenging due to dense wilderness obstacles that offer very limited free space, often narrower than the UAV's size, which makes such environments practically untraversable using existing methods.

Features:

We propose a new approach that enhances UAV traversability in the extremely dense wild through contact-driven adaptation to the environment. Our method enables three phenomena, within a unified framework, for handling diverse obstacles in the wild:

■ Push Aside

When encountering deformable obstacles like tree branches and leaves, the UAV can push them aside to create navigable spaces.

■ Pose Adjustment

Upon contact with rigid obstacles, such as tree trunks, the UAV relies on the contact points as pivots to naturally adjust its orientation, allowing it to maneuver through narrow corridors.

■ Replan After Unsuccessful Contact

If a contact attempt is unsuccessful, the UAV rapidly replans an alternative path in real-time.

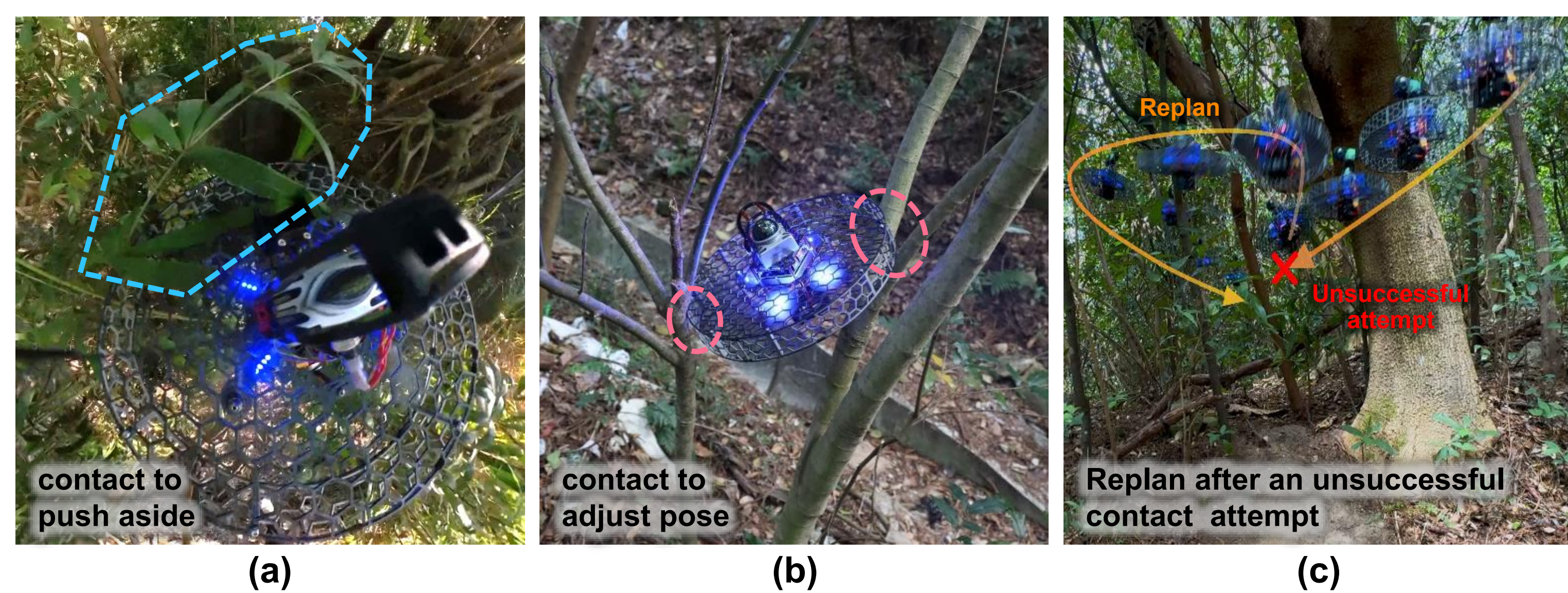


Fig. 1. Three phenomena that enhance traversability: (a) Push aside; (b) Pose adjustment; (c) Replan after an unsuccessful contact attempt.

System Overview

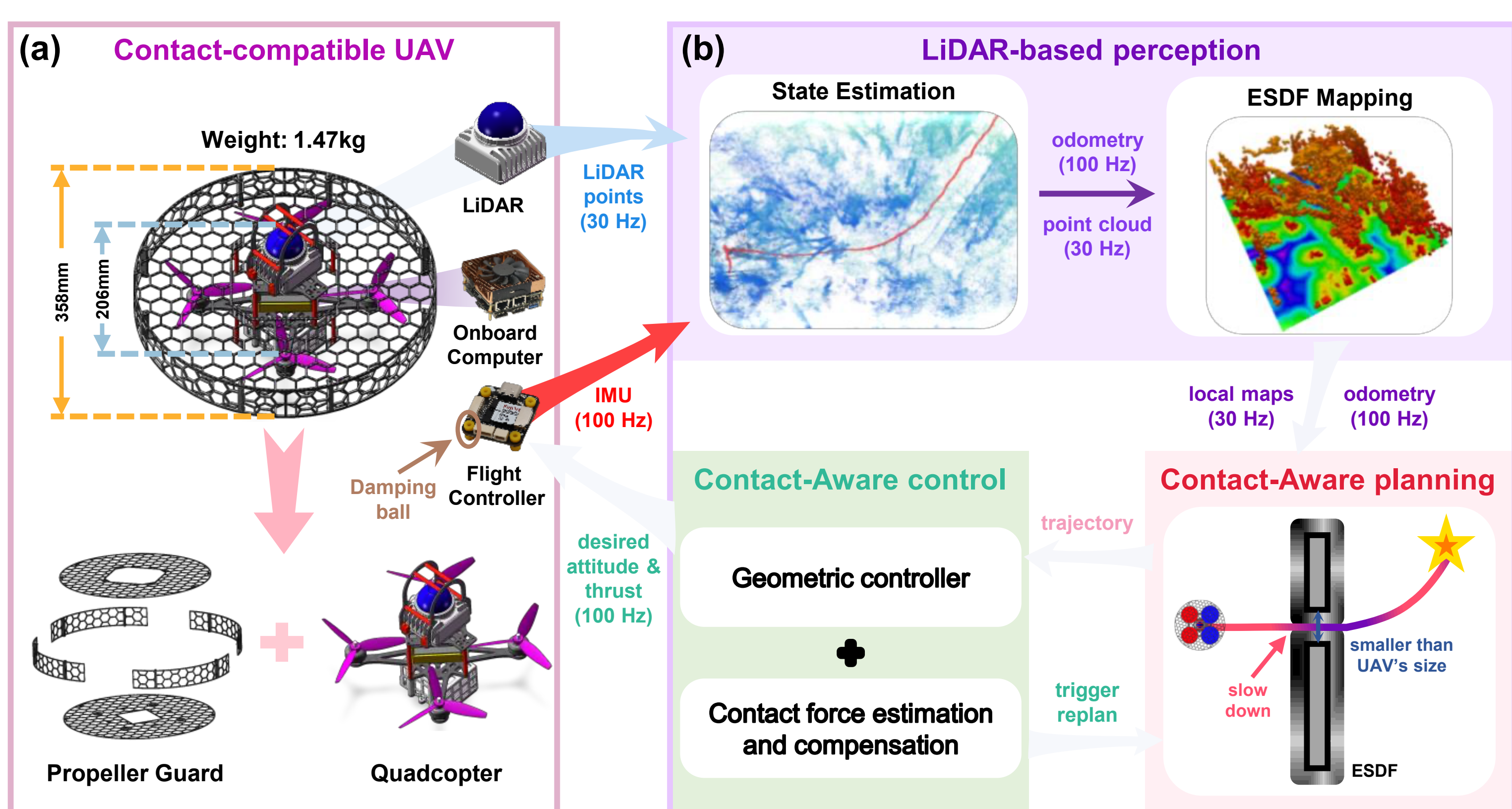


Fig. 2. Overview of our approach. (a) The contact-compatible UAV and its components. (b) The navigation system of our approach includes LiDAR-based perception, contact-aware planning, and contact-aware control.

Method

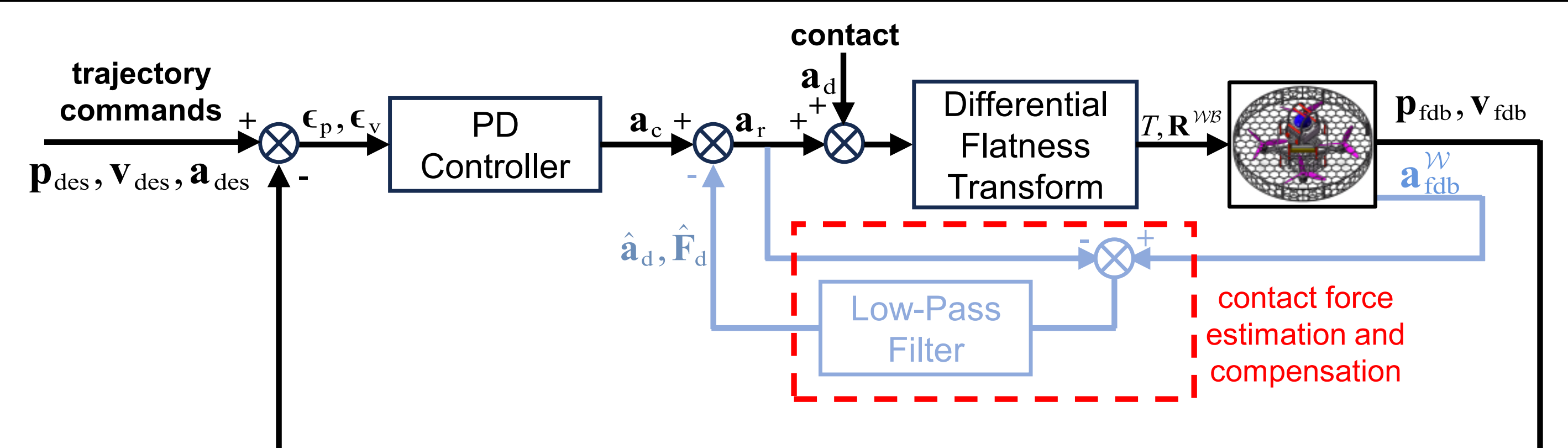


Fig. 3. The geometry controller with a built-in disturbance estimation and compensation module (dashed red box).

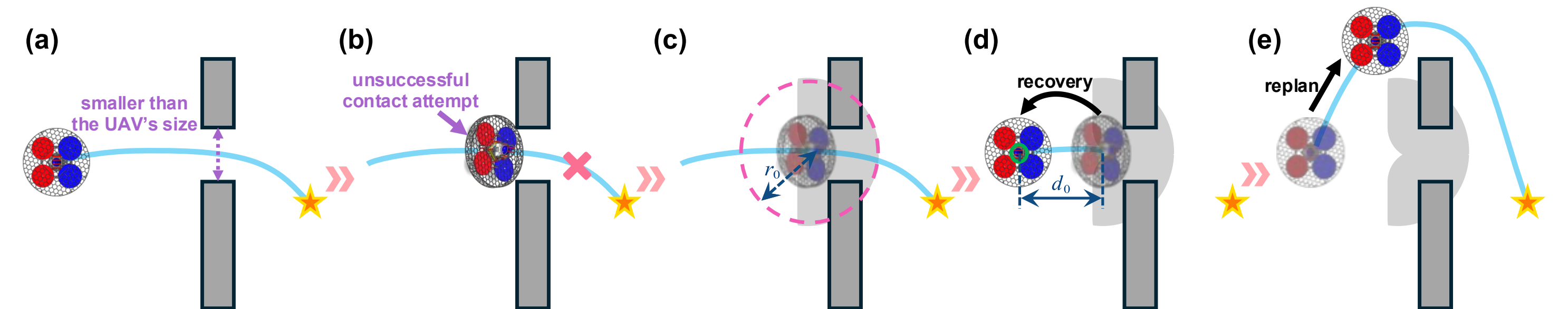


Fig. 4. Recovery strategy.

Field Experiments

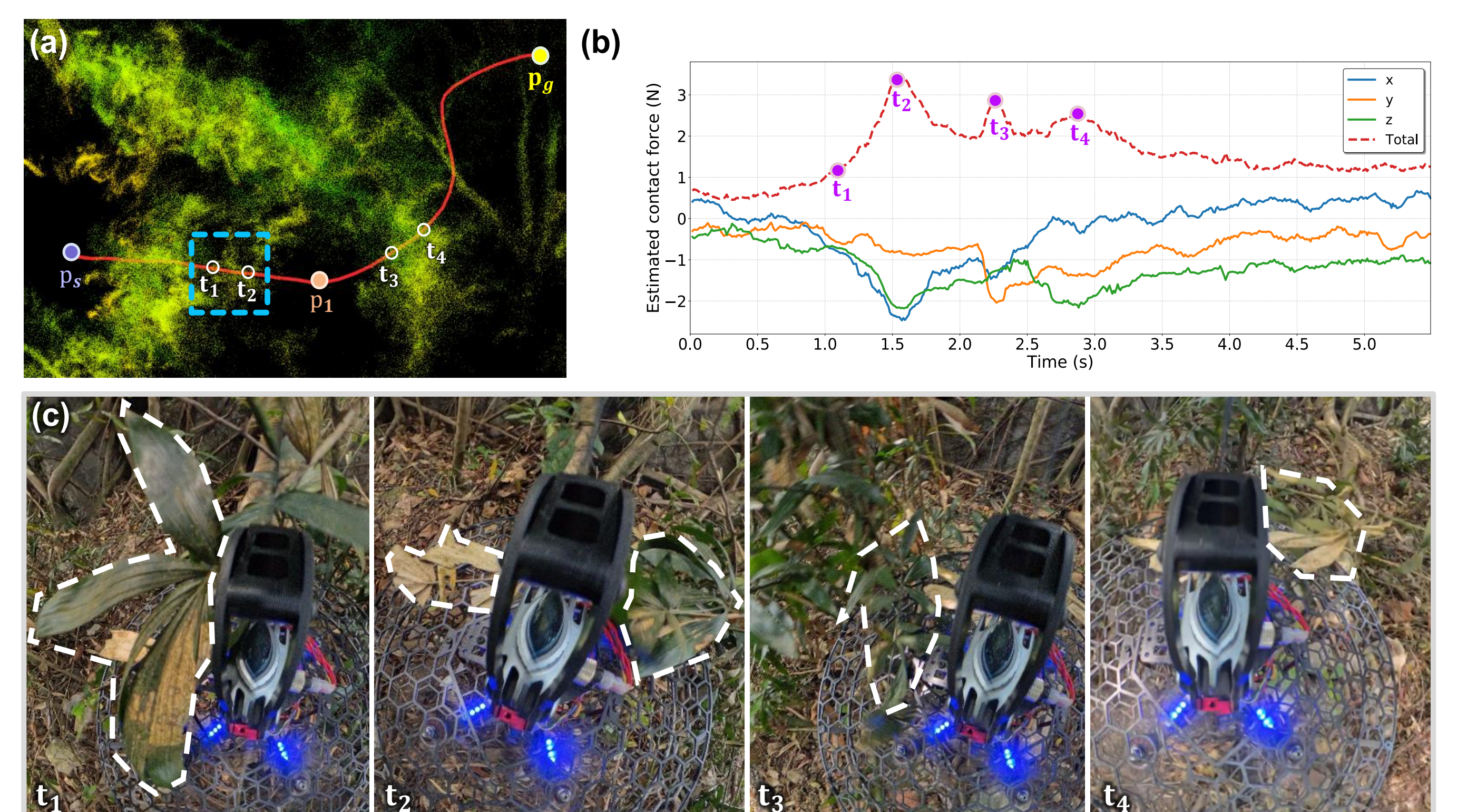


Fig. 5. Demonstration of the first phenomena

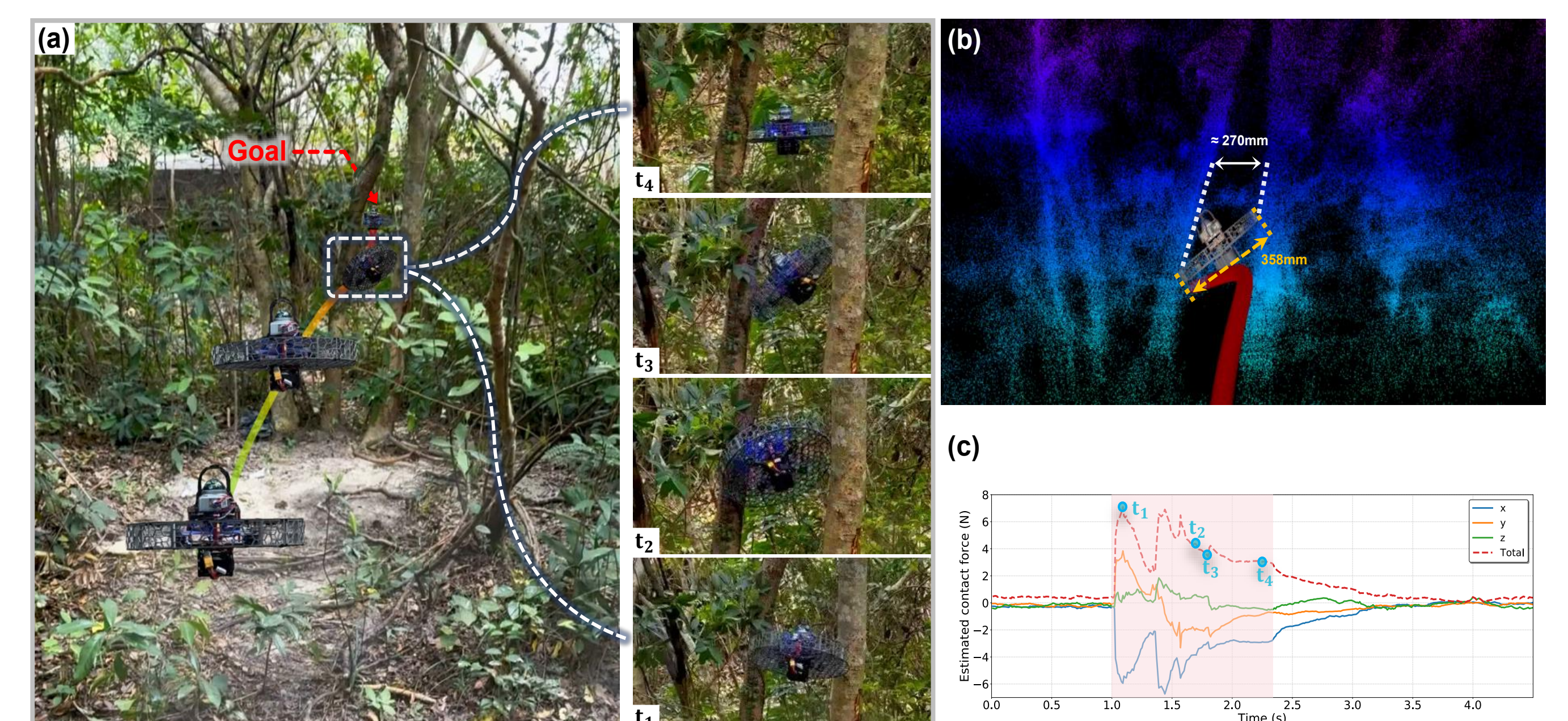


Fig. 6. Demonstration of the second phenomena

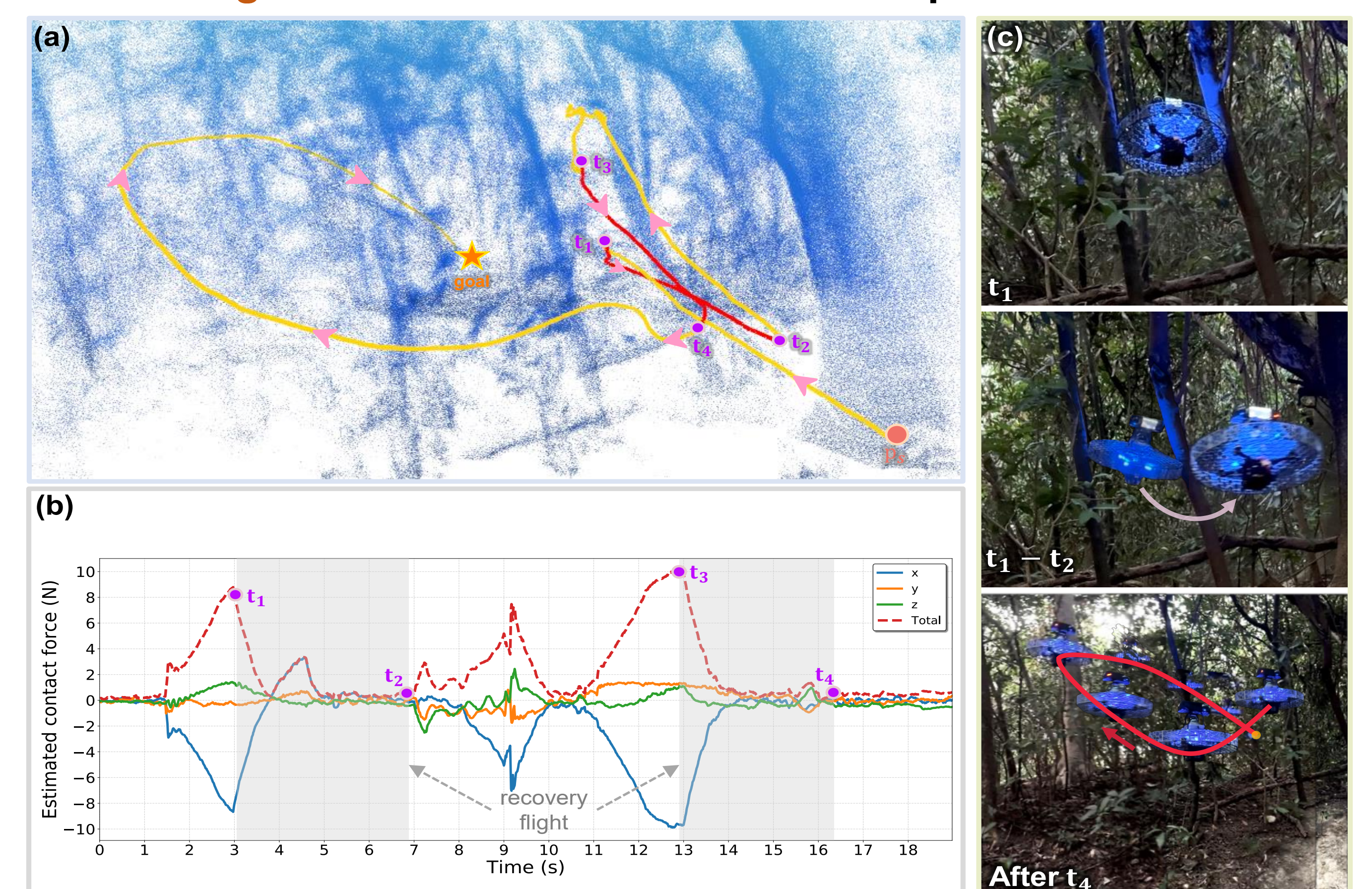
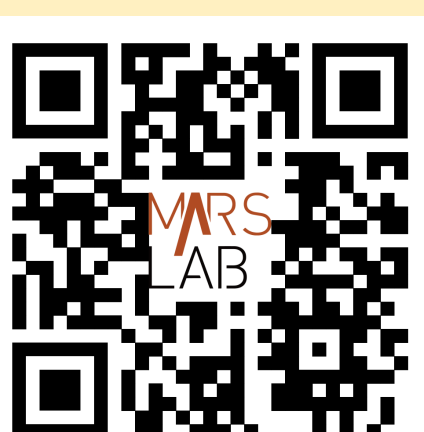


Fig. 7. Demonstration of the third phenomena

We also validated the navigation capability of our method in two highly dense vegetation scenes, achieving 70% and 90% success rates over 10 trials per scene, and evaluated its target tracking performance in various dense wild environments. (Please scan the QR code for videos)



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