

PROCEEDINGS

Enabling Autonomous Interception During Human-Guided Aerial Patrolling via a Single Neural Architecture

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ABSTRACT

In real-world aerial security and surveillance, a drone is often required to patrol a specific region as a primary navigation task while remaining ready to intercept an invader drone immediately upon detection. Traditional modular pipelines treat these as disjoint behaviors, suffering from high latency and error propagation that hinder agile response. Existing end-to-end frameworks typically focus on a single mode—either pure point-to-point navigation or continuous pursuit—lacking the flexibility to switch tasks dynamically based on visual cues. In this work, we propose an end-to-end dual-behavior policy that unifies navigation and pursuit within a single neural architecture. By mapping raw sensor data and high-level goals directly to control commands, our system achieves ultra-low latency (8.25 ms) and avoids the bottlenecks of decoupled perception-planning modules. The core of our framework is a learned objectness signal that acts as an autonomous, perception-driven trigger; it allows the drone to seamlessly switch from human-guided patrolling ("go there") to active target interception the moment a target is detected. To ensure robust performance, we introduce an intent-persistent search strategy that enables the drone to perform local searches around the last known target location during transient occlusions, preserving pursuit intent without handcrafted recovery logic. Furthermore, we address the severe data imbalance between common navigation states and rare pursuit opportunities using a focal loss-based training scheme, ensuring the policy remains highly sensitive to sparse target appearances. Evaluated in the Flightmare simulator, our method maintains a 90% tracking success rate at speeds up to 4.5 m/s in dense forest environments. This work demonstrates a significant step toward practical, human-autonomy synergy for complex aerial missions.

KEYWORDS

Object tracking; aerial pursuit; agile flight; end-to-end learning

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