MASTER'S PROJECT “AI DRONES” · INTELLIGENT SYSTEMS · SS2026

Autonomous Payload Delivery on Vision-Detected Landing Pads

Onboard YOLO Detection for Indoor FPV Drone Delivery

Docs Code

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01 Introduction

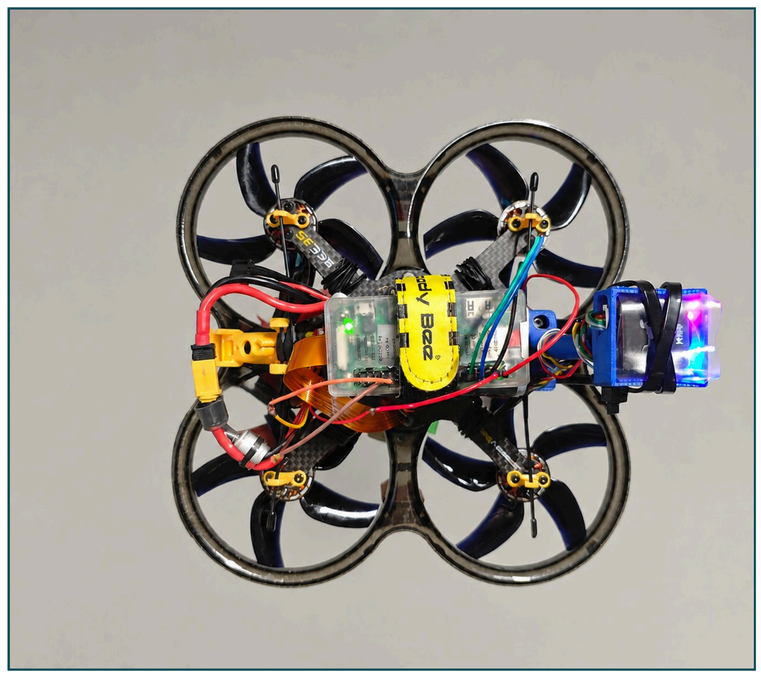
This project aims to extend a ready-built FPV drone with autonomous flight and an onboard AI camera that detects landing pads, so it can release a payload over them without a pilot in the loop. It is a step towards delivery drones that find a designated landing spot on their own indoors, where GPS is not available at all.

02 Objectives

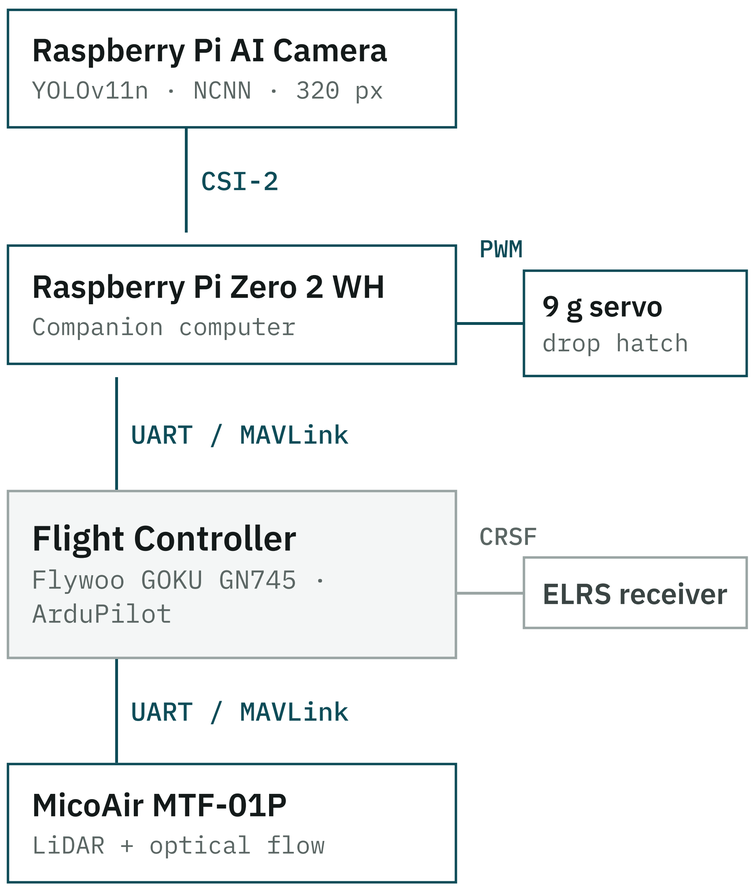
- Integrate autopilot and indoor position hold without GPS
- Detect landing pads reliably from a moving drone using onboard vision
- Release the payload via a servo-based drop mechanism

03 System Components

Platform	SpeedyBee BEE35 Pro 3.5" CineWhoop
Flight Controller	Flywoo GOKU GN745, ArduPilot
Companion Computer	Raspberry Pi Zero 2 WH
Sensors	Raspberry Pi AI Camera, MicoAir MTF-01P (LiDAR + optical flow)
Payload	9 g micro servo, 3D-printed frame extension
GPS	HGLRC M100 with compass
Motor	Emax Eco II 2004 3-6S 3000KV
Rotors	Gemfan 90mm D90-5 3.5" Ducted 5-Blade Rotors



04 System Architecture



05 Mission Sequence

1. **Command**
   The operator starts the mission on the companion computer, which arms the aircraft and switches the flight controller to GUIDED over MAVLink.
2. **Search pattern**
   The drone flies a preset pattern at hold altitude while the camera streams to the companion computer.
3. **Detection**
   YOLOv11n detects a landing pad from the onboard camera stream.
4. **Approach**
   The drone steers towards the detected pad and centers above it.
5. **Release**
   The servo opens the hatch and the payload drops.

ON FAIL

Monitoring runs throughout the flight. On failsafe, it lands immediately, in place.

Onboard detections with bounding boxes

06 Autopilot & Position Hold

Migrating from Betaflight to ArduPilot 4.6.3 unlocks autonomous GUIDED-mode flight with indoor position and altitude hold, no GPS: EKF3 fuses the MTF-01P’s optical flow and LiDAR over MAVLink. Every stage is rehearsed in SITL first, on the same firmware, which shaped three safety layers: geofences off by default, a read-only parameter check before every arm, and a continuous EKF-vs-rangefinder check that aborts on disagreement. A staged bring-up (arm/disarm → hover → detector → search → approach → drop) isolates one new unknown per real flight.

07 Challenges

- A misconfigured EKF height source plus a stale fence caused a real crash into the ceiling; the barometer then looked dead until a hung I2C bus, not failed hardware, was found four days later
- The same EKF-vs-rangefinder divergence has since recurred from an intermittent sensor dropout, still being tracked down
- Default PID gains caused visible oscillation on this frame; fixed with the harmonic notch filter, roll/pitch rate gains are back at default
- Indoor magnetic interference caused EKF compass yaw resets

08 What Works

- AltHold: stable on the real aircraft
- Loiter: holds position, drifts in the hall’s field
- Pad detection
- Payload release
- Takeoff & hold: autonomous GUIDED climb and hover
- Search: imperfect from drift

Object Detection · YOLOv11n · Autonomous Delivery