

INTRODUCTION

Aircraft exterior inspection is a critical safety function in commercial aviation maintenance. Between-flight walk-around inspections identify surface anomalies — corrosion, cracks, dents, and paint erosion — that can propagate into structural concerns if undetected.

Current manual workflows introduce inspector-to-inspector variability, limited documentation traceability, and safety risks from elevated-access equipment. As commercial fleets grow and MRO workforce constraints intensify through 2035, there is increasing demand for inspection-support technologies that improve repeatability and technician safety without replacing human authority.



Fig. 1 — A.N.T.S. quadcopter platform: onboard vision system, edge compute, and scanning beam

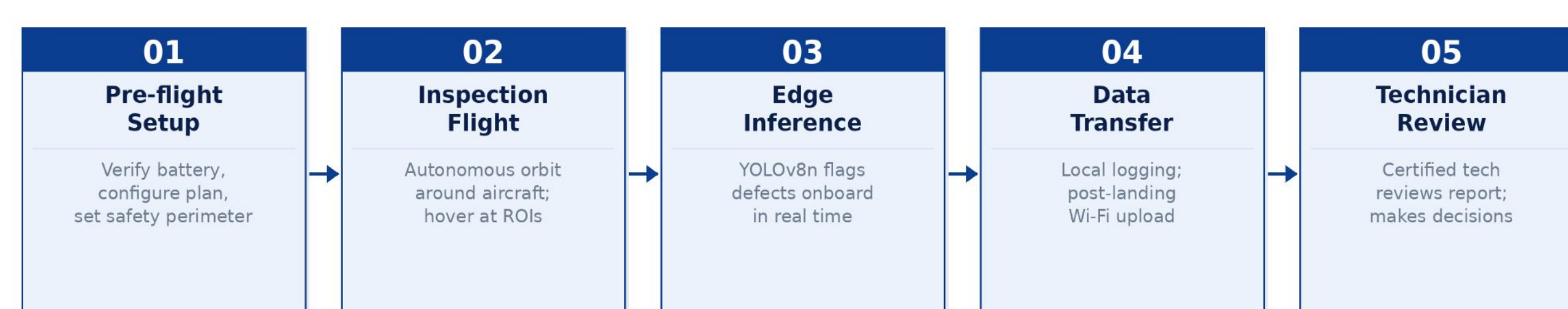


Fig. 2 - Process diagram further explaining the decision-making ability of the quadcopter.

OBJECTIVES

- Execute repeatable, operator-supervised autonomous inspection paths around stationary commercial aircraft.
- Run embedded YOLOv8n inference onboard to detect cracks, corrosion, dents, and paint erosion in real time.
- Generate technician-facing reports with time-stamped imagery, confidence scores, and location tags.
- Integrate into existing maintenance workflows without replacing certified technician decision authority.

DATASET

Source & Scope

Detection model training leverages the NEU Surface Defect Database (Song & Yan, 2013) as a pretraining base - a benchmark steel surface defect dataset widely used for transfer learning in industrial inspection tasks. Domain adaptation to aircraft surface materials and the four target defect classes (cracks, corrosion, dents, paint erosion) is an active component of ongoing system development. Expansion to aircraft-specific imagery is identified as a primary future work item.

HARDWARE PLATFORM

Subsystem	Components	Power
Airframe	Quadcopter · 4x 2814 750KV · 4x 60A ESC · 11.2" props	250–400 W hover 600–900 W peak
Flight Control	Pixhawk/Cube FC · Optical-flow · GPS upgrade path	~3 W
Vision	Hi-res camera · YOLOv8n edge inference	2–5 W
Power	4S–6S LiPo (14.8–22.2 V) · power distribution board	20–60 A avg

Table 1. A.N.T.S. hardware subsystem summary and power estimates.

METHODS

- 1. Pre-flight Setup**
Operator configures inspection plan, verifies battery state, and establishes safety perimeter around the stationary aircraft.
- 2. Autonomous Inspection Flight**
Drone executes standardized close-range orbit. Stable hover at ROIs: leading edges, lap joints, fasteners, coating transitions.
- 3. Onboard Edge Inference**
YOLOv8n processes frames in real time, flagging defect candidates with bounding boxes and confidence scores — no internet required.
- 4. Data Logging & Transfer**
Detection results logged locally during flight. Post-landing Wi-Fi or telemetry upload delivers data for report generation.
- 5. Technician Review**
Certified technician reviews generated report — time-stamped imagery, confidence metrics, location tags — and makes all maintenance decisions.

ANALYSIS

The computer-vision pipeline uses YOLOv8n — the nano variant of Ultralytics' YOLOv8 architecture — selected for compatibility with resource-constrained edge hardware. Software-controlled inference throttling keeps perception workloads within flight-safe power and thermal envelopes throughout the inspection mission.

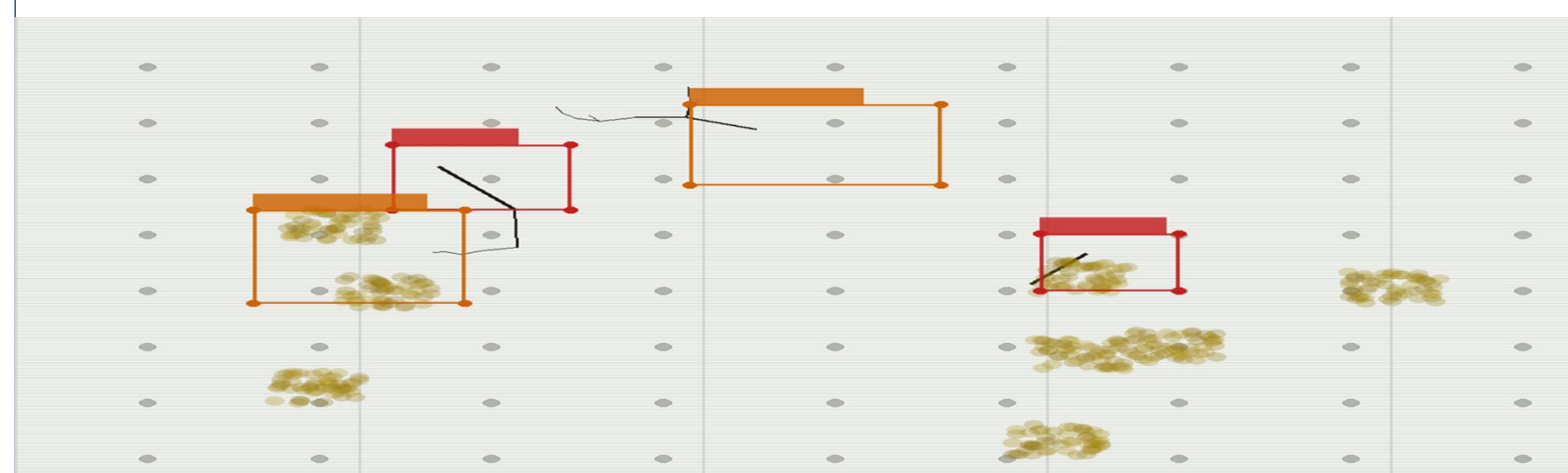


Fig. 3 — YOLOv8n defect detection output: cracks (red) and corrosion (orange) flagged with bounding boxes and confidence scores on simulated aircraft panel surface

FUTURE WORK

- Expand defect detection datasets across aircraft types and surface materials.
- Integrate LiDAR depth sensing for standoff distance control near reflective surfaces.
- RTK/GPS localization for outdoor ramp inspection compliance.
- Validate technician workflow usability in live MRO environments.

RESULTS

Integrated prototype testing in controlled environments confirms technical feasibility of the A.N.T.S. inspection approach across all core subsystems:

- Stable hover and close-range flight near aircraft-representative surfaces using optical-flow stabilization
- Successful real-time YOLOv8n inference on edge hardware within flight-safe power budgets
- Structured inspection report generation with time-stamped imagery and confidence metrics
- Operator-supervised workflow compatible with existing maintenance authority structures

CONCLUSION

A.N.T.S. demonstrates a credible, deployable pathway for autonomous inspection-support in aviation maintenance. By combining commercially-available UAV hardware with lightweight edge AI, the system improves inspection coverage consistency, documentation traceability, and technician safety — without disrupting established maintenance authority structures or requiring high-cost sensing platforms.

The operator-supervised autonomy model and modular hardware architecture provide a realistic TRL progression toward MRO deployment by 2035.

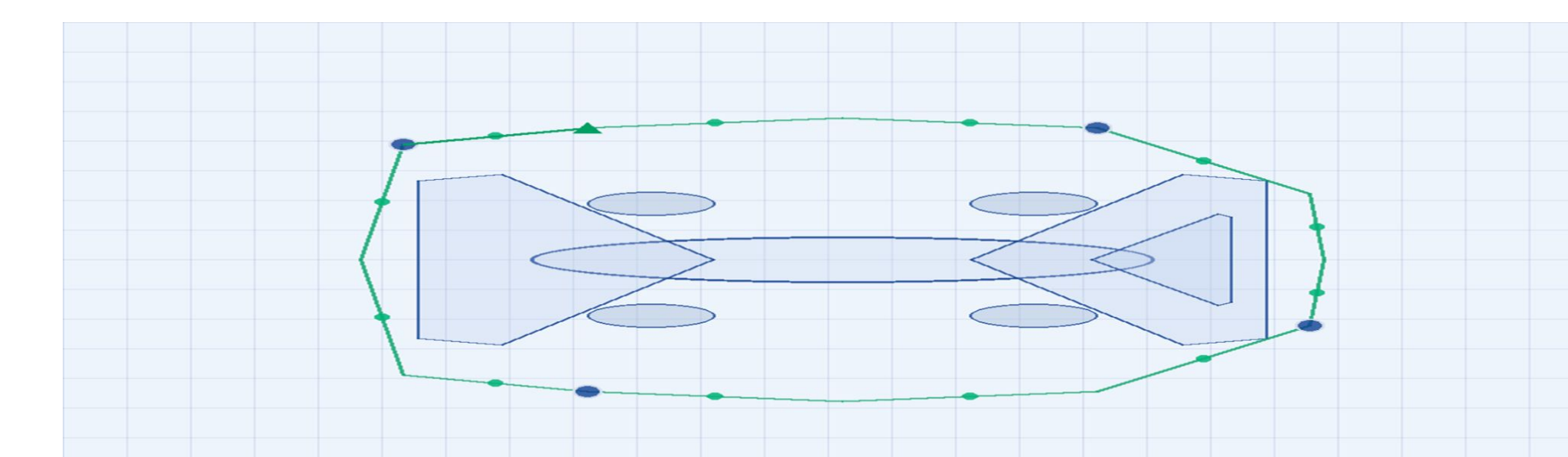


Fig. 4 — Top-down aircraft schematic: A.N.T.S. standardized inspection orbit (green) with drone waypoints (blue) and directional flow arrow

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