CASE STUDY

Aerial Monitoring with Drones for Methane Emissions Detection

Zemoso

Introduction

A Fortune 500 oilfield services provider partnered with Zemoso Labs to tackle a critical challenge: how to track methane emissions quickly and at scale during oil and gas production. Traditional inspections were slow, manual, and couldn't deliver real-time visibility. With net-zero targets looming, delays were costly. Together, we built an aerial monitoring solution powered by drones and a cloud-native analytics platform. Today, the system detects leaks in real time, pinpoints their location, and generates alerts and reports that operators can act on immediately.

Industry challenge

Methane is over 80 times more potent than CO_2 in the short term, and oil and gas production is responsible for about 40% of global emissions. The industry has long relied on ground patrols, handheld devices, and periodic surveys—methods that are labor-intensive and prone to delays. Every extra hour before a leak is detected increases safety risks, regulatory exposure, and reputational damage. Companies are under pressure to move fast, and aerial monitoring with drones has become a critical part of that shift.

Zemoso's partnership challenge

Our client's CCUS teams were working with disconnected systems — raw CSV files from well, field, and plant sensors sat in silos with little processing. Existing tools couldn't bring those signals together into a single dashboard, and alerting was inconsistent at best.

The ask was straightforward but far from simple:

- Create one system that links subsurface, surface, and plant data.
- Build proactive risk and alert management tied to compliance needs.
- Design an architecture that won't buckle as CCUS projects expand.

On top of the technical hurdles, there was the human side—aligning storage, capture, and transport teams under a shared system, while keeping regulators confident and data secure.

Impact created

The new platform changed how methane detection works on the ground:

- **Faster detection:** Computer vision models analyze drone footage in real time.
- **Stronger compliance:** Dashboards and reporting apps meet both regulator and internal audit requirements.
- **Reduced operational risk:** Manual inspections are scaled back, cutting delays and safety risks.

The company is now moving toward its 2030 and 2050 net-zero goals with measurable reductions in emissions.

How did we do this?

We co-created a platform that brings together drone-based sensing, deep learning–powered computer vision, and geospatial rendering into a single, resilient microservices platform. By replacing manual inspections with this real-time system, the client now has the scale and accuracy to meet emissions targets while staying ahead of regulatory pressure.
At its core, the platform combines edge detection, cloud-native processing, and geospatial rendering into one seamless workflow

- **Drone-to-Cloud Pipeline:** Drones equipped with methane sensors captured imagery and streamed it to the cloud, where the system ingested and organized terabytes of visual and sensor data.
- **AI-Powered Detection:** Designed an alert system where every anomaly was tied to a risk category, giving teams traceability for compliance.
- **Composable Services:** A distributed services layer ensured ingestion, analysis, and reporting ran independently, keeping the system reliable even under heavy load.
- **Intelligent Data Fabric:** The architecture balanced structured (asset hierarchies, alerts) and unstructured (drone imagery, video) data, enabling smooth analysis without bottlenecks.
- **Geospatial Precision:** A digital map layer turned raw detections into actionable insights—pinpointing leak locations directly on field assets.
- **Operator Experience:** From field engineers to compliance managers, role-based dashboards delivered the right data at the right fidelity—whether it was live alerts or regulatory reports.

Complex Engineering Highlights

Behind the scenes, several engineering breakthroughs made this possible:

- **Computer Vision at Scale:** Deep learning models processed vast amounts of unstructured drone data in real time, replacing traditional inspections.
- **Hybrid Data Orchestration:** Coordinating relational, unstructured, and cached data stores ensured smooth performance across workloads.
- **Geospatial Rendering:** Cesium GIS delivered near-digital twin accuracy, helping teams pinpoint leaks down to the asset level.
- **Fault-Tolerant Services:** With a microservices architecture, failures in one module never brought down the system—critical functions like alerting stayed live.
- **Edge-to-Cloud Speed:** Near real-time processing meant methane releases were identified within minutes, reducing emissions and regulatory risk.

Conclusion

Zemoso Labs worked with the client to reimagine methane monitoring, turning drone imagery into fast, actionable data. What once required slow manual surveys is now a live, automated system that helps one of the world's largest energy providers cut emissions, improve safety, and take concrete steps toward its net-zero future.

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