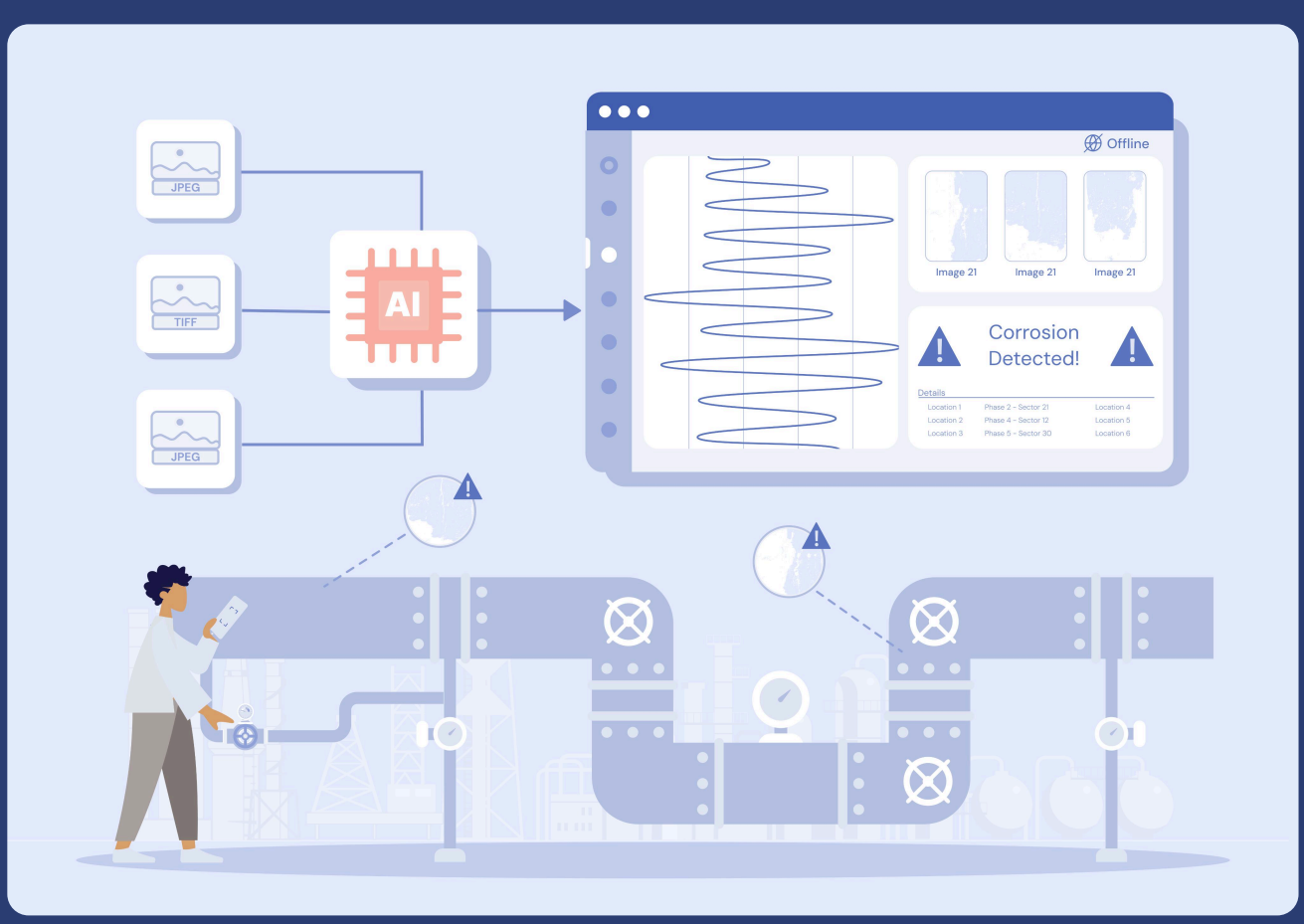
CASE STUDY

Enabling AI-powered field operations for pipeline inspections and corrosion detection



Zemoso

Introduction

Over 64% of damage incidents in crude oil pipelines are caused by corrosion. For oilfield operators, delayed detection leads to asset degradation, safety risks, and unplanned downtime. Existing manual inspection methods are slow and inconsistent—especially in remote sites with limited connectivity.

Zemoso partnered with a global oilfield services company to build an offline, AI-powered pipeline inspection platform. The system enables engineers to upload image data, detect corrosion using on-device machine learning, and review damage visually through an interactive gallery interface. The result: faster triage, traceable decisions, and fewer failures in the field.

Industry challenge

Corrosion is one of the most common and costly pipeline issues. Manual reviews miss early signs, especially across large asset footprints. Without automation, damage can go unnoticed until failure occurs. Delayed response increases operational risk, impacts compliance, and drives up maintenance costs.

Zemoso's partnership challenge

The client needed a system that could process high-resolution image data, detect corrosion with precision, and function entirely within localized environments without reliance on cloud infrastructure. Balancing machine learning compute needs, responsive UI delivery, and local resource constraints presented a unique architectural challenge. Zemoso designed a containerized AI platform that balanced inference performance, usability, and traceability without relying on external infrastructure.

Impact created

The system reduced inspection review time from hours to minutes by eliminating manual damage identification. Field engineers now make repair decisions on-site with actionable image overlays highlighting corrosion zones. By automating image analysis the system minimizes subjective interpretation, accelerates damage triage, and enhances compliance readiness.

How did we do this?

The solution ingests high-resolution TIFF images from pipeline cameras and applies pre-trained ML models to detect corrosion. These detections are rendered as transparent polygon overlays and fused with JPEG visualizations, accessible via an intuitive gallery interface within the AI Workbench.

Solution highlights

- **Dual-Format Image Ingestion and Storage:** To support high-fidelity image processing, the system accepts and stores images in both TIFF and JPEG formats. Engineers upload inspection images in TIFF (for analysis) and JPEG (for visualization) formats using a React-based interface. TIFFs are stored in MinIO, while metadata is recorded in PostgreSQL. This setup removes the need for manual file conversion or preprocessing.

- **On-site ML inference:** A Flask-based service automatically processes TIFF files using pre-trained ML models. Corrosion is detected and marked spatially. All inference runs locally, ensuring consistent performance at remote sites and avoiding dependency on internet access.

- **Gallery interface for field review:** Engineers review results through a responsive React gallery built with Material UI. It supports zoom, scroll, and filter functions for fast comparison across pipeline sections. Redux handles state management, ensuring smooth interactions even with large image sets.

- **Offline-first architecture:** All services run on local infrastructure using Docker containers. Nginx manages routing between components. This setup supports full inspection workflows in bandwidth-limited environments and ensures inspection data remains on-prem.

- **Traceability and metadata:** The PostgreSQL database links each image to its analysis results, inspection status, and timestamps. Engineers can query by pipeline segment or inspection cycle. This audit-friendly structure also supports trend analysis over time.

How did Zemoso deliver excellence

Zemoso delivered an offline-capable, AI-powered pipeline inspection platform designed for the realities of field operations. By combining machine learning, real-time visualization, and a lightweight deployment model, the system enables faster, more reliable corrosion detection and supports safer, more efficient asset management.

To hire your custom product pod, write to sales@zemosolabs.com today!