Use Case

Enhanced Rail Track Inspection with Edge AI

Realtime Fault Detection to Ensure Safety and Operational Efficiency

/ Challenge

Rising Traffic Demands Fast, Accurate Rail Inspections

High-speed rail traffic is growing across major corridors, creating increased demand for frequent, accurate inspections. Strict federal regulations require fault detection and reporting, and delays in addressing issues can result in severe speed restrictions (e.g., reducing speeds from 125 mph to 30 mph).

Such restrictions not only disrupt service quality but also have significant financial consequences. Maintaining uninterrupted operations is critical to ensuring passenger safety, service reliability, and revenue stability.

/ Summary

WHO: A leading passenger rail operator

WHAT: The company manages high-speed and conventional rail networks, requiring regular inspections of track geometry, rail profiles, and catenary systems. Timely detection of faults is essential to avoid operational restrictions.

HOW: Autonomous inspection vehicles equipped with advanced sensors and Edge AI recognize and select image data in realtime to detect rail and tie faults with precise geolocation. Only critical insights are transmitted wirelessly, enabling faster, data-driven maintenance decisions.

VALUE: The solution reduces downtime, prevents costly speed restrictions, and optimizes maintenance scheduling, delivering measurable business impact while ensuring safe and efficient rail operations.

/ Project Objectives

Ensuring Safety and Operational Continuity in Rail

- Ensure timely detection and resolution of rail faults
- Maintain operational speeds and minimize service disruptions
- Comply with strict regulatory inspection and reporting standards
- Increase inspection efficiency across a growing, high-demand rail network

/ Solution

Edge AI and Smart Data Management for Realtime Fault Detection

The rail operator has deployed autonomous track inspection vehicles equipped with Edge AI and aicas Edge Data Management. High-resolution cameras and advanced sensors continuously capture rail and tie data, which is processed locally in realtime. Unnecessary information is filtered out, while defects such as cavities (X-ray), cracks, and deformations (rail geometry via laser) are detected with pinpoint geolocation accuracy—even at high speeds. Relevant insights are transmitted wirelessly to maintenance teams, enabling:

- Proactive interventions and optimized scheduling.
- Continuous feedback loop to refine AI detection models.
- Improving accuracy and compliance over time.
- Seamless regulatory compliance.
- Enhanced safety and reliability.
- Sustained operational continuity.

> *By combining Edge AI with aicas' intelligent Edge Data Management, we see real benefits in rail operations: faults are detected faster and more accurately, which enhances safety, improves efficiency, and supports operators in staying compliant with strict regulations.*
>
> **Rail Integrator**

/ Solution Key Features

Smart Data Selection. Transmit Only What Matters.

aicas Edge Data Management ensures that only relevant, selectively chosen, and event-driven data is transmitted. Unlike conventional track inspection systems that send all collected data to the cloud, aicas recognizes and selects data directly on the edge device. It automatically filters out blurred, redundant, or irrelevant data before transmission.

This can **reduce transmitted data volume to less than 10%** of the total collected and enables reliable mobile data transfer even over limited 4G (LTE) or 5G bandwidth. The same principle applies to laser-based rail geometry measurements, where faulty readings are filtered out before error reports are generated. Available selective transmission modes:

- **Manual:** Users decide which data to receive and when.
- **Rule-based:** Predefined rules determine what data is transmitted.
- **AI-based:** Trained AI models autonomously identify relevant data and determine the optimal transmission time. A proof-of-concept achieved **96% accuracy** in data relevance detection.

/ Solution Components

- Autonomous inspection vehicles
- aicas Edge Data Management Platform for realtime AI-based image processing at the camera
- Edge AI algorithms for fault detection and geolocation mapping
- Wireless transmission system for critical insights to operators
- Integration with maintenance scheduling systems for actionable decision-making

/ Results & Benefits

Safe, Efficient, and Reliable Rail Operations with Realtime Insights

- **Ensures uninterrupted rail operation** through faster fault detection
- **Minimizes speed restrictions and downtimes**
- **Proactive maintenance** enabled through wireless insights and optimized scheduling
- **Streamlined compliance** with federal reporting standards
- **Smarter resource** use for maintenance teams
- **Improved accuracy** over time through continuous AI learning
- **High business impact** by safeguarding service reliability, passenger safety, and revenue

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