Hosted by: 国家铁路局 National Railway Administration of the People's Republic of China 機電工程署 EMSD MTR

IRSC 2025

Advancing Railway Safety through Innovations and Collaborations

Hong Kong, China 25th - 30th November 2025

Image Analytics for Efficient Overhead Line Monitoring

Andrew Lo
Chief Power Systems Manager (Operations)
MTR Corporation Limited

Eunice Ngai
Data Engineer
MTR Corporation Limited

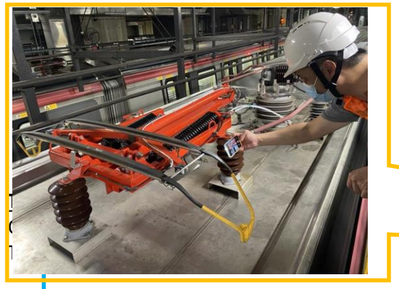
Background

- **Interface between OHL[#] and pantograph**
  A smooth interface ensures maximized utilization for both OHL and pantograph. Arcing may result from the interface under practical situations.

- **OHL-Pantograph Monitoring System (OPMS)**
  OPMS monitors electric arcs at the OHL pantograph interface using train-roof CCTV during passenger operations.

[#] In the context of this presentation, OHL are contact wire(s) that is(are) in contact with pantographs.

Interface between Train-Borne Equipment and OPMS



Train Roof CCTV

Capture footage of Arcing
and High Temperature

Server

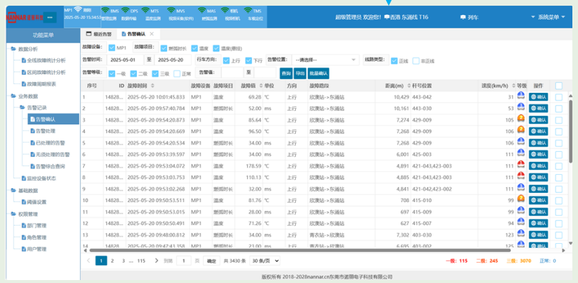
Collect data and backup

On-board Computer

Collect data from the camera and TMS, then send it
to server via wireless transmission

Train Management System

Provide information of station, section, distance, date and time

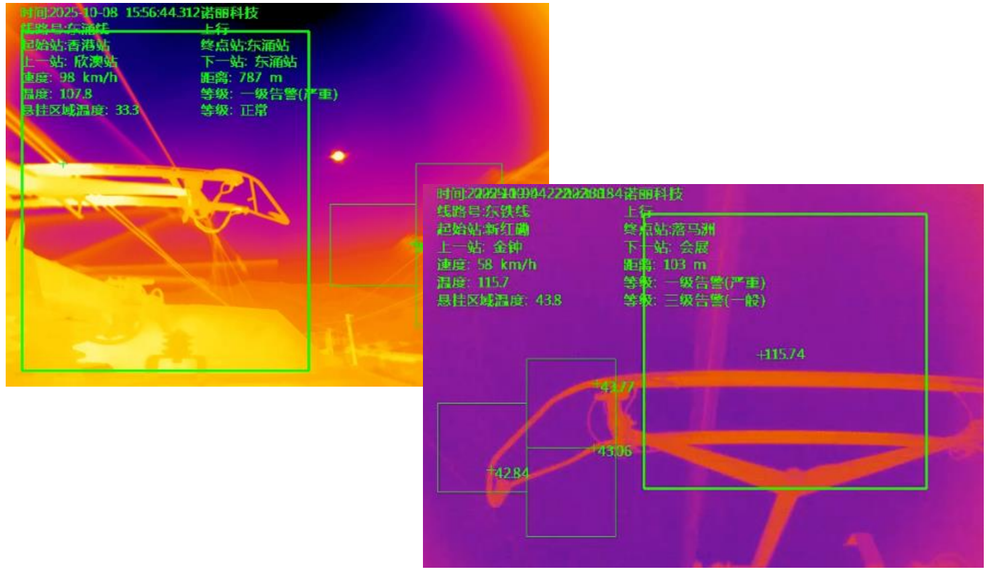


Man-Machine Interface

Generate data and information with image and video

The Types of Alarms

- **Abnormally high temperature (°C)**



- **Arc duration (ms)**

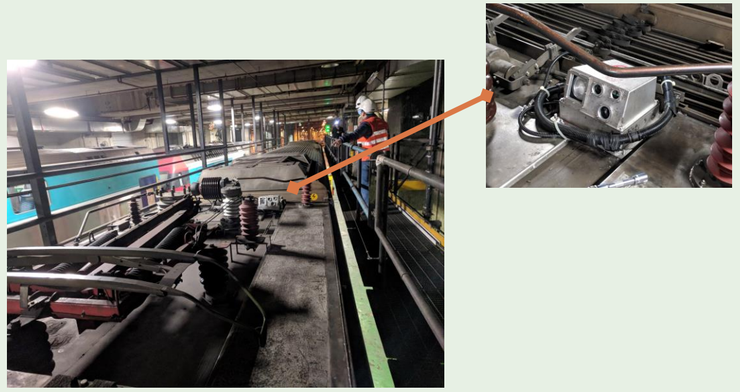
Equipment for separating two electrical zones

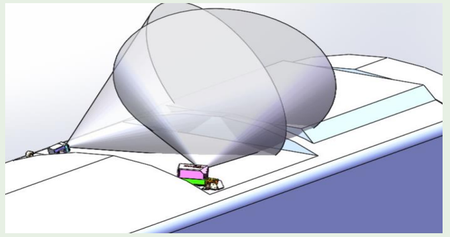
Collaboration Background

- **Challenge from Nuisance Alarms**
  Quantities of nuisance alarms may reach a level beyond checking them manually, highlighting the need for automation.

- **Proprietary Model**
  The built-in OPMS model cannot be modified to meet the requirements from users with different use cases.

- **Need for Automated Solution**
  A scalable automated system is essential to ensure timely and accurate maintenance responses to alarms.





Objectives

- **Innovative Alarm Preprocessing**
  The project introduces a new method to preprocess OPMS alarms enhancing initial data handling.

- **AI-Based Object Detection**
  Integration of AI object detection models improves efficiency and accuracy of alarm review .

- **Need for Automated Solution**
  A scalable automated system is essential to ensure suitable protocol for maintenance responses to alarms.

- **Optimised Workflow**
  Only relevant alarms are flagged for manual review, optimizing the overall maintenance process.

Approach

Excessive Spark

Yellow Flame

Spark

Normal Spark

No Visible Spark

Spark size increase

OPMS Alarms
Up to hundreds of videos per day

OACS

Pre-Process → Spark severity + Spark location

There are hundreds of alarms from OPMS that need to be processed, OACS is to help users handle the vast number of alarms by

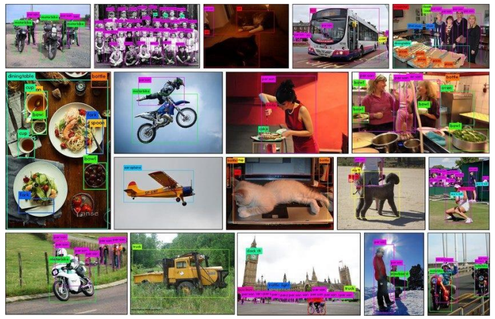
1. **Classifying the alarms** according to their levels, and
2. Providing the **chainage and equipment information** of the spark.

Method

A fine-tuned YOLOv5 object detection architecture is used in OACS for spark detection.

Transfer Learning

Images of electric arcs were fed into the model for transfer learning to adapt it for specific task in OACS.



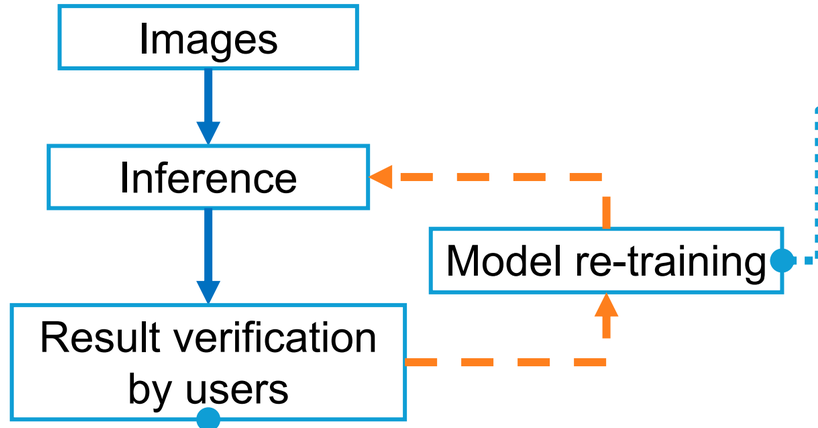
General YOLOv5

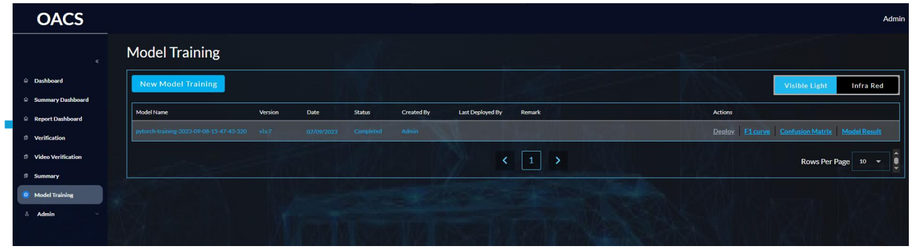
Transfer learning

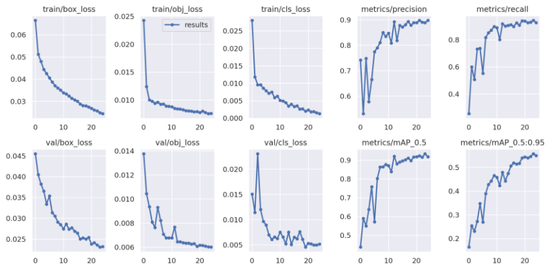
OACS YOLOv5

Model Retraining

With new labels collected from user verification, the AI model can be re-trained and deployed for more accurate prediction for future data.







Manually Triggered
Automated

Results

Further classify alarms with visible arcs from OPMS into four categories. According to data from January to March 2025,

OPMS Alarms
29,896

No Visible Spark
= 13,654 (45.7%)

Spark detected
= 16,242 (54.3%)

Normal Spark
= 12,007

Spark
= 2362

Excessive Spark
= 1235

Yellow Flame
= 638

Conclusions & Impact

- **AI-Enhanced Overhead Line Monitoring**
  Integration of AI has significantly improved the accuracy and efficiency of overhead line monitoring systems.

- **Reduction of Non-Critical Alarms**
  Fine-tuned object detection models reduce false alarms, streamlining maintenance responses and enhancing system reliability.

- **Scalable AI Applications**
  The AI approach can be extended to other visual detection systems and infrastructure monitoring scenarios.

- **Enhanced Safety and Efficiency**
  AI optimises maintenance operations, enhancing safety, reliability, and operational efficiency in railways.

www.irsc2025.com

Hosted by:

国家铁路局
National Railway Administration of the People's Republic of China

機電工程署
EMSD

MTR