



Abstract Title: Intelligent Safety 2.0 for Light Rail Utilizing IoT, AI, Computer Vision & Data Analytics

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Background / Context

The Light Rail in Hong Kong opening in 1988 was designed as an open system environment under manual driving mode, with close interfaces with road users. It requires high vigilance by Train Captains in observing the dynamic traffic situation to drive safely. There is a need to eliminate human factor issues as far as reasonably possible.

Objectives

An integrated safety platform is developed – aiming not just to provide intelligent functional safety, but also to provide a system-to-system collaborative platform. Systems can talk to each other for achieving intelligence from each other, providing anticipative alerts to operators, passengers and other road users – namely Intelligent Safety 2.0 for Light Rail.

Methods / Approach

The Safety Platform Core - Integrated Speed and Position Supervision System (iSPS) is a home-grown patented innovation certified with Safety Integrity Level 2 of IEC61508, combining the applications of Global Positioning System, Radio Frequency Identification and other trainborne sensors and signals to form an Integrated Safety Platform to enable continuously real-time tracking of Light Rail Vehicles with real-time alerts. iSPS provides a one-stop accurate and reliable solution for manual driving: speed supervision, platform safety, turnout safety, fleet management and inter-vehicle management.



While iSPS is developed as the core platform, we identified Computer Vision to be a vital tool to empower iSPS to detect the dynamic external environment with other road users and pedestrians which could not be controlled. By utilizing cameras installed at strategic locations, real-time footage is captured and analysed to detect potential hazards in the high-variable environment, such as eyesight-blocking obstacles, passengers standing beyond platform yellow line, jump red road vehicles, and jaywalkers. These features form a comprehensive safety net, protecting passengers, pedestrians, and other road users from potential hazards.

iSPS provides 3-level responsive alerts for Train Captains – audio reminder, traction inhibition and automatic service braking, and also train bell triggering, pedestrian warning triggering or public address broadcasting for alerting road users nearby. By utilizing big driving data analytics, a revolution in performance monitoring with iSPS is achieved, being a round-the-clock driving coach fostering behavioural change in defensive driving; thus, greatly improving LR driving, platform and junction safety.

Results / Findings

The integrated Intelligent Safety 2.0 platform offers a cost-effective alternative to full-scale signalling or safety systems. It provides the safety functions at a lower construction price and reduced project management costs. The interoperability across systems on the Platform yields significant synergistic benefits. Also, the Platform provides a unified interface for our operators to react and respond effectively, and the alerts had been categorized and prioritized in advance.

The launch of the Intelligent Safety 2.0 platform has been well recognized by the operators, as demonstrated by a remarkable reduction of over 50% in relevant alert scenarios. Additionally, the platform's Big Data capabilities have enabled proactive and targeted coaching with the outlining Train Captains, allowing us to effectively standardize the driving behaviour of the train captains.

The Computer Vision plays a key role in predicting incidents by taking consideration of train movement as well as the object speed and trajectory. This advancement allows for anticipated detection capabilities that traditional sensor technologies, such as radar and lidar, cannot achieve. This innovative breakthrough has been recognized by both local and international institutions, and several patents have been granted in Hong Kong and the UK.

Conclusions

The platform enhanced the LR network's safety performance by constantly monitoring and detecting risks. It prevented accidents, reduced hazards, and triggered automatic safety actions. It made the railway safer and more efficient for the train operators and the passengers.

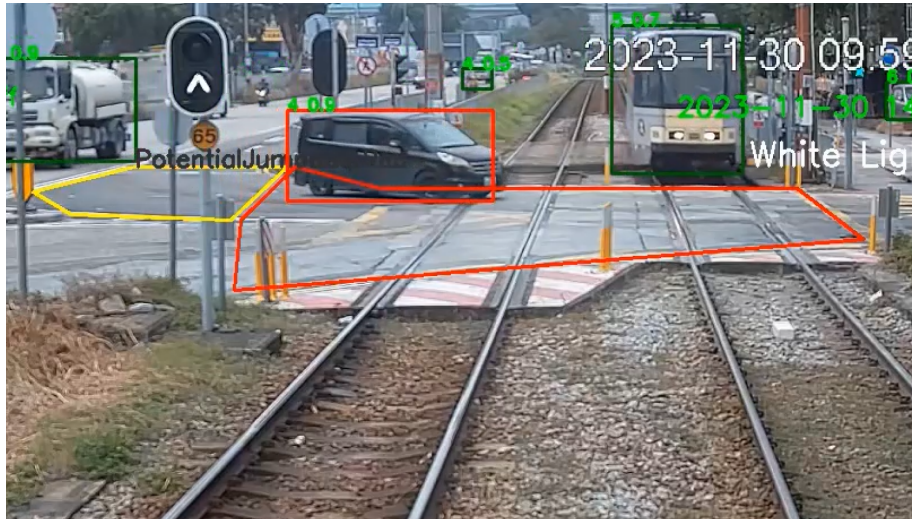


Figure 1 - Detection of Jump-Red Vehicle and Alerting Train Captain with 3-level Alerts

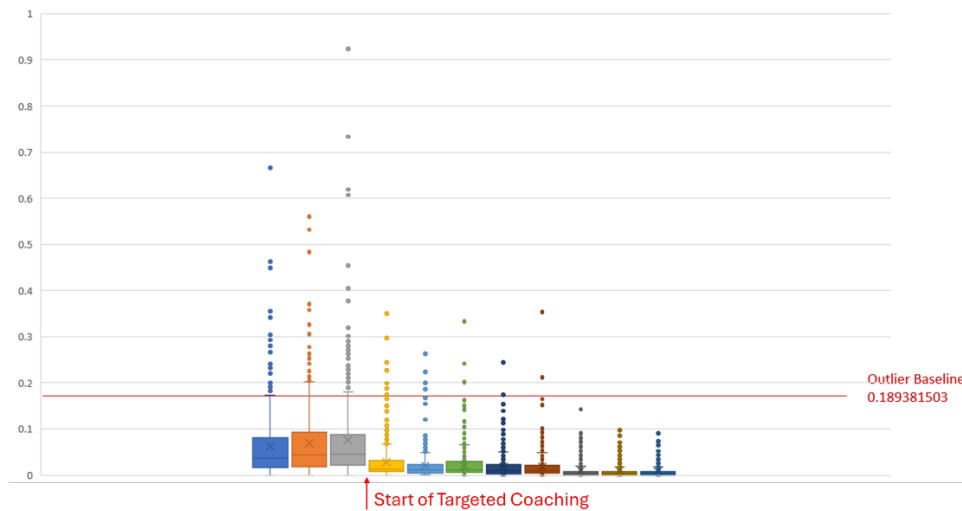


Figure 2 - Reduced Number of Outliner after Big Data Analytics on Driving Data with Targeted Coaching