

SMARTVISION TRACK CONDITION MONITORING: REVOLUTIONISING RAILWAY INFRASTRUCTURE MAINTENANCE



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Introduction

EKE-Electronics, through its partner, Hind Rectifiers Ltd, is introducing to the Indian market its SmartVision Track Condition Monitoring solution. SmartVision complements traditional geometry measurements by providing continuous vibration measurements obtained from in-service trains by capturing the vibration response from the wheels as they traverse the track thereby minimising the risk of missing significant changes or emerging issues.

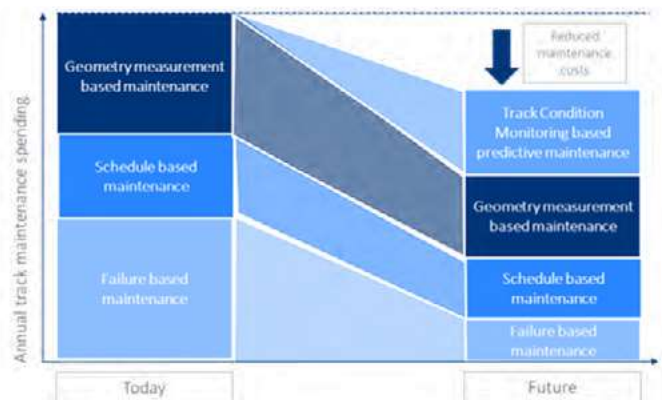
Capabilities

With a sampling rate of 5000 samples per second, SmartVision unveils a wealth of valuable information. The collected measurement data is transmitted to the cloud for processing, utilising reliable communication technologies such as 3G, 4G, WiFi, and GNSS. By analysing the dynamic rail response, the system can detect defects on the railhead, identify instances of rail support loosening, and even monitor changes in the ballast and other supporting structures. Users receive timely alerts and warnings, via a web-browser, enabling proactive maintenance and ensuring the safety and efficiency of railway operations.

Value Proposition of SmartVision Track Condition Monitoring

SmartVision is a decision support tool providing unique information that helps to determine the optimal time

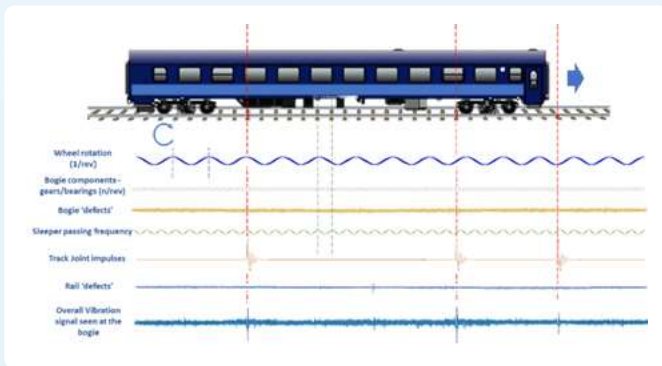
of maintenance intervention. Its value proposition lies in its ability to significantly reduce maintenance costs compared to traditional maintenance strategies such as geometry-based, schedule-based, and failure-based maintenance. While these conventional approaches rely on predefined maintenance schedules or reactive responses to track failures, SmartVision offers a predictive-based maintenance approach. By leveraging advanced data analytics, SmartVision continuously monitors the condition of the track, detecting early signs of wear, damage, or potential failures. This proactive approach enables maintenance teams to intervene before major issues occur, preventing costly repairs and minimising downtime. By addressing maintenance needs based on real-time data and predictive insights, SmartVision optimises maintenance activities, reduces overall costs, and ensures better track performance and longevity.



Distinguishing between vibration caused by the bogie from that caused by the train.

Any vibration sensor mounted on a train's bogie results in a very complex signal characteristic containing signatures from both the train (wheel, bearings, etc) and the track (joints, points, sleepers, track defects etc). Figure 2 illustrates a typical (simulated data) signal build-up of a composite vibration signal containing both synchronous bogie components and asynchronous track components.

Whilst the bogie related components are closely synchronous with each other, the track components are asynchronous both to themselves and other components. The vibration signal requires radically different signal



processing to successfully and repeatedly isolate the rail and wheel components. A further challenge is that the traditional method of 'sampling' the bogie data on a periodic basis, in accordance with a predefined analysis schedule to characterise and trend its behaviour, cannot be used for track monitoring, where it is essential to capture and analyse 100% of the data when the train is moving, to ensure full coverage of the network.

The approach taken to solving this challenge is to use edge processing to apply sophisticated algorithms that have been developed to filter out the synchronous components from the bogie in real time, leaving a residual signal comprising mainly of track related components. This data can then be analysed to determine the condition of the track. This is a data driven approach that requires no other sensor data to control the processing.

Vibrations resulting from track defects often exhibit a tendency to cluster in specific regions. Following the noise filtering process, the signal data is mapped to established whether the vibration is caused by a fixed asset or a point of interest on the track.



Defects Detected

Since 2019 EKE has cooperated with VR FleetCare, the maintenance unit of the Finnish Railways and FTIA, the owner of the track infrastructure in Finland on development and field verification of SmartVision Track condition monitoring. This fruitful collaboration has resulted in the identification of several noteworthy instances: railhead defects and loosening of supporting structures, broken rails, broken fishplates, squats, railhead defects in switches and crossings and corrugation. Notably, these detections were not captured by the measurement train as they had not yet surpassed the predetermined warning or alarm thresholds.

Of particular significance is SmartVision's capability to identify rail surface defects and provide timely indications for rail grinding requirements. Previously, the decision to perform grinding was primarily based on subjective feedback from drivers regarding rough ride areas. However, with the implementation of SmartVision, objective measurements can now be leveraged to determine the necessity for grinding, ensuring a more informed and data-driven approach to maintenance decision-making.

Measurement Kit

The measurement kit is designed to be as simple as possible. It consists of 5 components: vibration sensors, sensor gateway, radio router including SIM card, train antenna for Wi-Fi/3G/4G/GNSS communication (5G available), power and internet cables. A maintenance team can install the kit in as little as 1 day.

Automated monitoring

The SmartVision cloud platform analyses the collected data to separate issues related to fixed assets, such as switches and insulation joints, from those specific to track sections. SmartVision Track Condition Monitoring utilises advanced

algorithms and machine learning techniques to transform the acquired raw data into powerful Condition Indicators. These indicators reflect the developing faults within your monitored assets, enabling you to take proactive measures. SmartVision Track Condition Monitoring can detect anomalies in the rail surface, rail support and track bed, height deviations, areas of track causing the bogie to oscillate and corrugation.

Trend Curves

A unique aspect of this system lies in its capability to effectively map data to corresponding assets. Leveraging positioning data, the system intelligently identifies the presence of switches or joints along the track. When such assets are detected, the relevant data is linked to them, enabling the generation of degradation curves that depict the asset's condition over time. In cases where fixed assets are not allocated, these locations become points of interest, prompting data collection whenever a train traverses the area. As before, trend curves are generated for these points of interest, providing valuable insights into their performance trends and displayed through a user-friendly web browser interface.

Hunting and corrugation

The sensor gateway incorporates a 3-axis gyroscope and accelerometer which is used to determine areas on the track causing the train to oscillate, also known as hunting. Algorithms have been developed to determine track fragments containing areas of corrugation.

Indian Partnership

Hind Rectifiers Ltd (HIRECT) has been in the business of designing and manufacturing electronics, electrical, electro-mechanical power conversion products for the last 65 years. In the Rail Sector, HIRECT have been supplying and maintaining Class A equipment like state-of-the-art IGBT based converters, transformers, traction motors, electrical panels, HVAC, etc for all types of railway rolling stock.

EKE-Electronics' has selected HIRECT as its trusted business partner in India based on HIRECT's expertise on rolling stock technology and extensive service network across all Indian Railway production units, and workshops. Indian Railway and Metro authorities are already showing interest in understanding the benefits they will reap by implementing SmartVision.

Conclusions

Embarking on a track condition monitoring journey may seem daunting. It requires careful planning, investment in sensors and data acquisition systems, and the expertise to analyse and interpret the collected data. SmartVision facilitates in acquiring real-time data about railway track infrastructure from in-service trains. Continuous measurement and trend analysis provides actionable insights and early warnings about potential defects, allowing you to prioritise maintenance efforts effectively. This solution streamlines the process of identifying, understanding, and diagnosing track issues, enabling rail operators to make informed decisions and take appropriate actions promptly. By implementing SmartVision, maintenance planning can be optimised, resources allocated efficiently, and operational disruptions minimised.

