



SMART INDIA HACKATHON 2025



TRACS

Track Reliability and Condition Surveillance

TITLE PAGE

- **Problem Statement ID :** 25020
- **Problem Statement Title :** Development of indigenous contactless Integrated Track Monitoring Systems (ITMS) for Track Recording on Indian Railway.
- **Theme :** Smart Automation
- **PS Category :** Hardware
- **Team ID :** We use Arch BTW
- **Team Name :** We use Arch BTW



Development of low-cost, modular ITMS

❖ Proposed Solution :

- Track Recording Cars (TRCs) currently in use rely upon 3rd party vendors, have high maintenance costs and closed source software along with a lack of customisable capabilities.
- We seek to address this issue by creating a modular open source solution using locally available / made in India parts while still maintaining similar or better accuracy.
- Current TRCs use 360 rotating LiDARs for Schedule Of Dimensions(SOD)/Maximum Moving Dimension(MMD) infringement detection and use gauge sensors for track profiling which wear easily with use and need gauge blocks for calibration. Our solution will use Solid state LiDARs for more accurate SOD/MMD infringement detection and optical line laser / line scan camera for contactless track geometry measurement along with other required sensors including IMU(gyro + accel) , optical accel encoder. Modularity will be maintained by using M12X rugged ethernet connectors for reliable data transfer and modularity.
- Proposed solution complies with RDSO Specification TM/IM/448, Rev. 1: 2023 and EN 13848 standards.

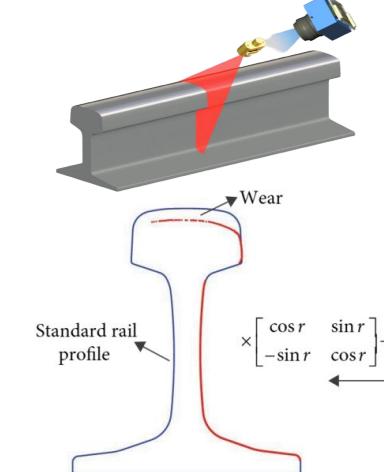
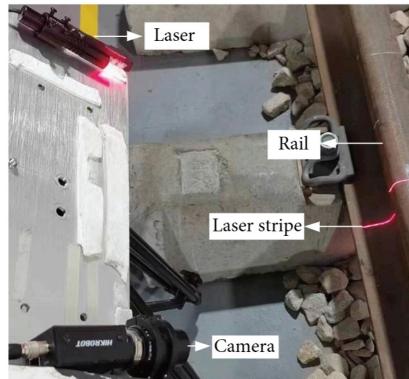
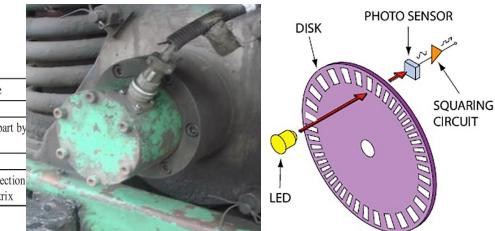
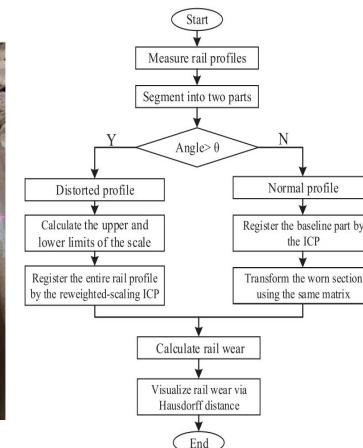
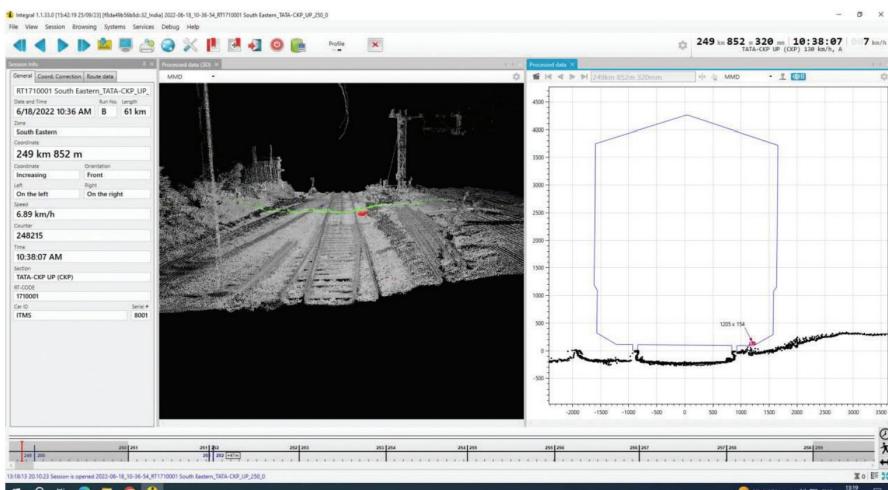


FIGURE 2: Rail profile req

**Comparing captured profile
with standard profile**

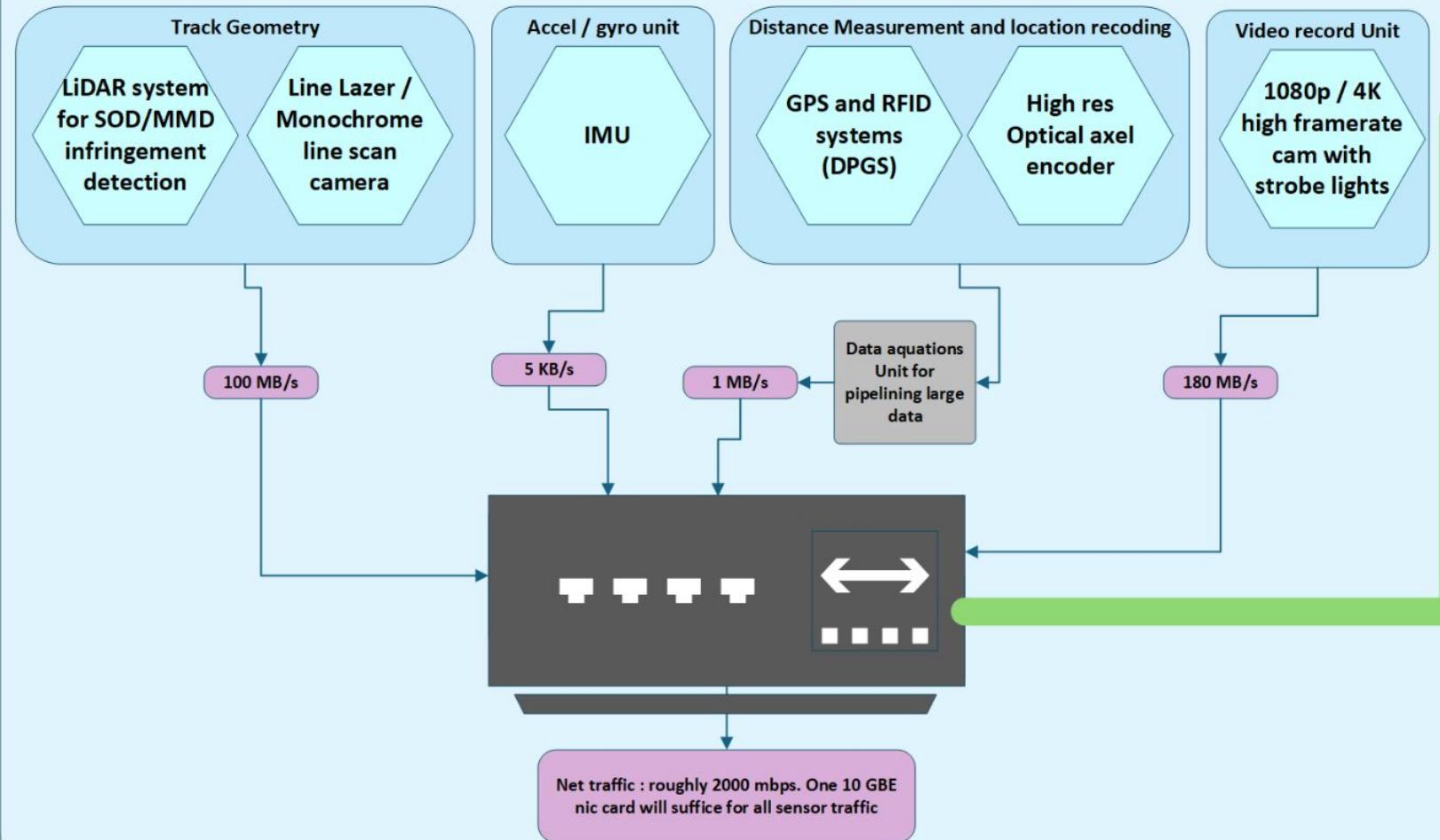


Tachometer/Optical Encoder

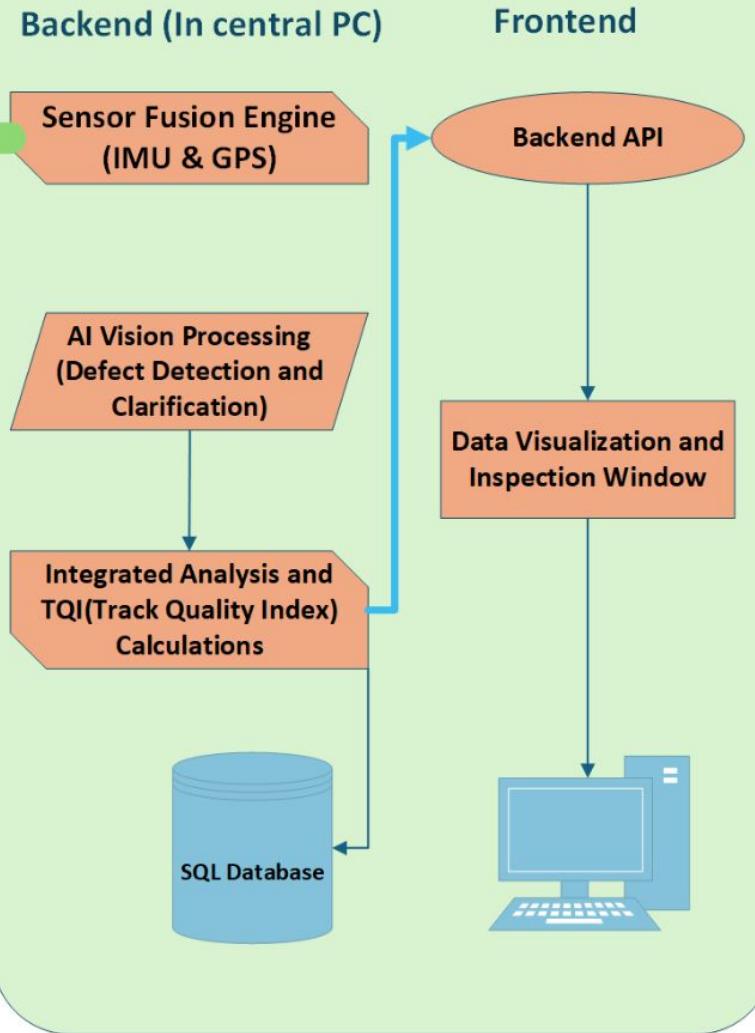


**SOD/MMD envelope
scanning with LiDAR**

Hardware Layer



Software Layer





FEASIBILITY AND VIABILITY

1. Feasibility

Proven Technologies: Leverages proven laser profiling systems , GPS , optical tachometers and RFID scanners as per the detailed RDSO specification.

Operationally Read: Designed for IR's TRC's to operate from 0-200 Kmph in harsh Indian climates (-10°C to 55°C).

Predictive Maintenance: Enables real-time defect reporting via various sensor sub systems and automated wear measurement, reducing costs and preventing failures.

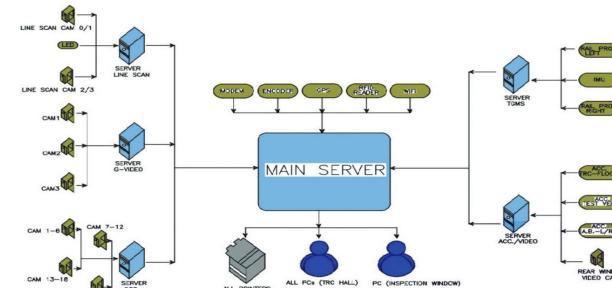


Fig. 3 : System Architecture

Old system : Requires 5 servers/computers

2. Challenges & Risk

Location Inaccuracies : Overcomes GPS inaccuracies by using RFID based scanners alongside GPS systems for accurate reporting.

Harsh Environments : Ensuring reliability under extreme on-track conditions like high vibrations and flying debris and dirt buildup.

Laser System Reliability : A key challenge is maintaining the high accuracy of contactless laser sensors at high speeds and under harsh environmental conditions like sunlight, dust, flying debris, and vibrations.



Old gauge based solutions need manual calibration and suffer from wear and tear

3. Our Solution & Strategy

Laser System Reliability: use of IR lasers to reduce brightness interference and alternatively use of **line scan cameras as suggested by IPWE** for track profiling .

RFID-Based Synchronization: Utilizes RFID readers for precise, automated location data, ensuring high accuracy in defect reporting as mentioned in the ZITMS specification.

Automated Clearance Scanning: using solid state LiDARs in place of old 360 rotating lidars for better accuracy and reliability

Advanced Signal Filtering: The system utilizes customisable **band-pass filters** to isolate specific track irregularities from signal noise, ensuring high measurement accuracy.



solid state LiDAR for SOD infringements



IMPACT AND BENEFITS

❖ Potential Impact on Target Audience :

- Safer & smoother railway travel experience
- Quicker detection of track problems → fewer accidents
- Better ride comfort for passengers
- Real-time data helps railway engineers act quickly
- Improves train punctuality & overall service quality

❖ Benefits of the Solution :

- **Social** : Enhances passenger safety and trust in railways.
- **Economic** : Saves money by reducing foreign dependency & maintenance costs.
- **Operational** : Faster maintenance, less downtime.
- **Environmental** : less manual checks → less fuel usage.
- **Technological** : Promotes Indigenous Track Monitoring System under "Make in India"
- **Modularity** : Easy to upgrade, maintain & expand

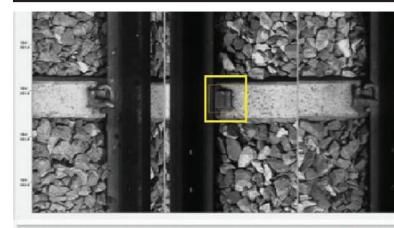


Fig.10 : Reporting of missing clip.

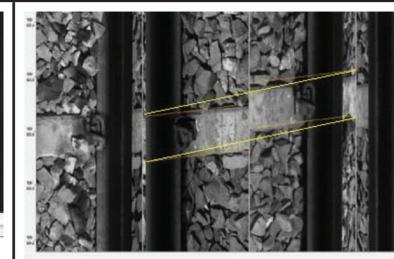


Fig. 11 : Reporting of misaligned sleeper.

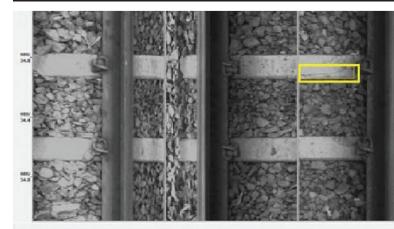


Fig. 12 : Reporting of Cracked Sleeper.

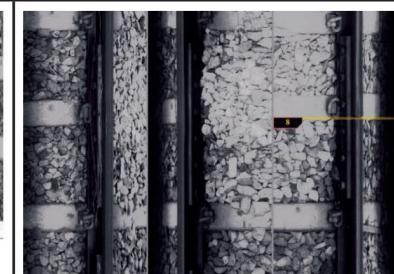
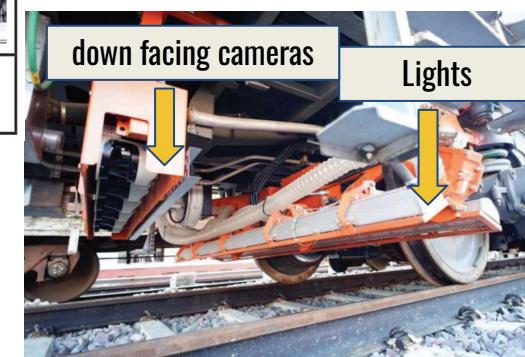


Fig. 13 : Reporting Joint Gap.



Use of ethernet for modularity and high speed data transfer



Track condition monitoring sub system



RESEARCH AND REFERENCES

OFFICIAL GOVERNMENT DOCUMENTS, STANDARD SPECIFICATIONS AND RESEARCH PAPERS

Official documents:

- [STANDARD SPECIFICATION : Railway applications - Track - Track geometry quality - Part 1 : Characterization of track geometry](#)
- [STANDARD SPECIFICATION : Railway applications - Track - Track geometry quality - Part 2: Measuring systems - Track recording vehicles](#)
- [GOVERNMENT OF INDIA : Reliability of Track Geometry Reported by \(TRCs\) : Provisions in En 13848 : Part 2 and Findings](#)
- [GOVERNMENT OF INDIA \(MINISTRY OF RAILWAY\) : Technical Specification for Integrated Track Monitoring System from Zero Speed](#)
- [GOVERNMENT OF INDIA : Introduction of Modern Track Inspection Technology in Indian Railways - Integrated Track Monitoring System \(ITMS\)- New TRC](#)

Research papers:

- [Dynamic Inspection of a Rail Profile Under Affine Distortion Based on the reweighted-Scaling Iterative Closest Point Method](#)
- [A Fast Global Optimal Strategy for Iterative Closest Point Using 2D-BnB and Its Application to Rail Profile Registration](#)
- [Solid-State LiDAR based-SLAM: A Concise Review and Application](#)
- [A Progress Review on Solid-State LiDAR and Nanophotonics-Based LiDAR Sensors](#)

Prototype:

- [TRACS- TRACK RELIABILITY AND CONDITION SURVEILLANCE Frontend interface](#)