

# White Paper: TrackGuard AI — Radar & Sensor-Based Obstacle Detection System for Railway Safety

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**\*\*Note\*\***: This is a conceptual innovation — not a working prototype. This project is released for free public use to improve global railway safety.

## 1. Executive Summary

Railway accidents caused by human or animal intrusion, fallen debris, or mechanical obstruction on the track remain a critical safety challenge worldwide. This white paper introduces TrackGuard AI, a cost-effective, radar-based smart fencing system integrated with rail track occupancy sensors to detect and prevent such incidents in real time. Unlike existing high-cost camera or drone-based systems, TrackGuard AI leverages radar technology, AI-driven object classification, and on-track sensors to provide 24/7 intelligent surveillance, significantly reducing false alarms and improving response times without needing thermal imaging or human operators.

## 2. Problem Statement

Current railway safety infrastructure in most developing and even many developed countries lacks:

- Real-time obstacle detection on open tracks
- Scalable and affordable surveillance
- Integration between sensor-based detection and train communication systems

This leads to:

- Frequent animal/person collisions
- Derailments from unmonitored track debris
- Lack of timely alerts to drivers and control rooms

## 3. Proposed Solution: TrackGuard AI

TrackGuard AI includes:

1. Smart Radar Fence Units: Installed along railway tracks using low-power mmWave radar.

2. Rail Track Occupancy Sensors: Detect train presence using axle counters or vibration sensors.
3. AI Processor (Edge Node): Filters data to send only valid alerts.
4. Wireless Communication Module: Sends GPS-tagged alerts to drivers and control centers.

#### **4. Technical Advantages**

- Radar works day/night, all-weather
- AI classification reduces false positives
- Track sensors prevent irrelevant alerts
- No thermal cameras needed = lower cost
- Fast local processing
- Easy integration with LTE-R or railway signals

#### **5. Real-World Use & Differentiation**

Unlike existing systems that use cameras or simple train sensors, TrackGuard AI uniquely combines radar, track sensors, and AI. It is ideal for open tracks, developing nations, and large-scale deployments where thermal imaging or drones are impractical.

#### **6. Use Cases**

- Indian Railways
- African rail networks
- EU cargo railways
- Metro systems with open tracks
- Smart train corridors like Hyperloop pilots

#### **7. Implementation Plan (Phased)**

Phase 1: Prototype on 2 km test track

Phase 2: Train AI with real-world data

Phase 3: Integrate with communication system

Phase 4: Deploy in high-risk zones

#### **8. Patent Potential**

Patentable due to unique integration of radar and rail sensors for low-cost 24/7 monitoring without thermal imaging or cameras.

## 9. Conclusion

TrackGuard AI is a practical, scalable, and innovative solution for global railway safety. It combines advanced detection, smart filtering, and real-time alerts to prevent derailments and save lives.

## Future Integrations & Customization

**TrackGuard AI is a modular and expandable system.** While the current concept outlines radar-based obstacle detection and sensor-based train presence tracking, additional capabilities can be integrated based on local needs, including but not limited to:

- **Rail health monitoring** (crack detection, stress sensors, thermal shift tracking)
- **Advanced edge AI** for predictive analytics
- **Environmental sensors** (flood, fog, landslide risk)
- **Drone-based inspection or backup alerting**
- **Energy efficiency or solar-power integration**

These extensions can be explored in collaboration with relevant partners.

**To customize TrackGuard AI for specific regional or technical requirements, or to co-develop additional features, please contact the creator.**

## License & Availability

This project is based on the **Apache 2.0 License**, but with additional restrictions for commercial deployment:

- ☒ **Free for** public research, education, and humanitarian use
- ☐ **Not permitted** for commercial, government, or national infrastructure use without explicit permission

Any for-profit use, resale, or enterprise integration **requires a commercial license or partnership agreement** with the creator.

- **Creator:** [Sidhant Negi](#)

- **Repository:** [TrackGuard-AI on GitHub](https://github.com/Sidhant1s/Sidhant1s) – Conceptual radar and sensor-based railway safety system developed by Sidhant Negi. Open for collaboration; contact for commercial use.

Suggested attribution:

*“Based on TrackGuard AI by Sidhant Negi – <https://github.com/Sidhant1s/Sidhant1s>”*

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GitHub: <https://github.com/Sidhant1s/Sidhant1s>

Note: This white paper is released “as-is” without any warranties. Community contributions and deployment collaborations are encouraged.