Fraunhofer IPM

Track Geometry Measurement System

Measuring track geometry with submillimeter precision

The TGM uses the light section method to generates high-resolution digital 3D data from tracks and key track components.

Railroad tracks have to bear heavy loads, especially from freight and long-distance trains. Over time, this causes changes in the rail track geometry. The Track Geometry Measurement System (TGM) automatically, precisely, and contactlessly measures rail track geometry at high speeds.

Digital measurement data for smart maintenance

Predictive railroad infrastructure maintenance includes regular geometry checks of the rail track. Geometry faults can cause rails, fixings, and sleepers, as well as the train wheels, to wear prematurely. Frequent and precise measurements are required to detect geometry faults on rail tracks before they cause any damage to track components. The TGM measures rail track geometry with millimeter precision at high speeds, eliminating the need to close tracks for inspection. A measurement accuracy in the submillimeter range can be achieved by reducing the driving speed.

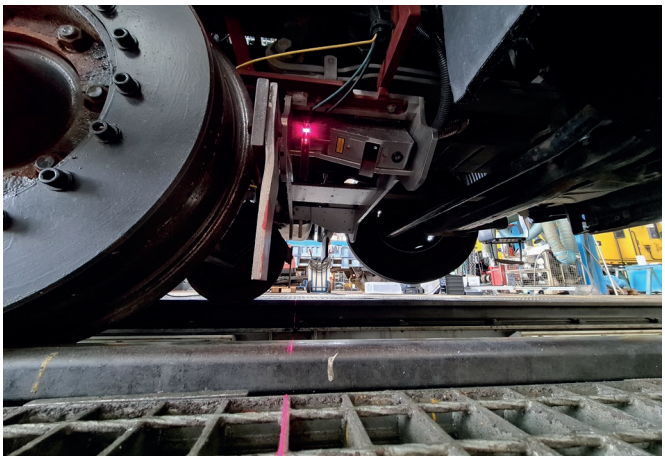
The system records the position of the track, the ballast bed, the sleepers, and the fixings in a single measurement run and delivers digital 3D data. In addition to the rail track geometry, information on various track components can be automatically extracted from the 3D point clouds. Digital measurement values from individual field measurements can be automatically compared, enabling long-term status monitoring of the track infrastructure.

Light section method for high-precision 3D profiles

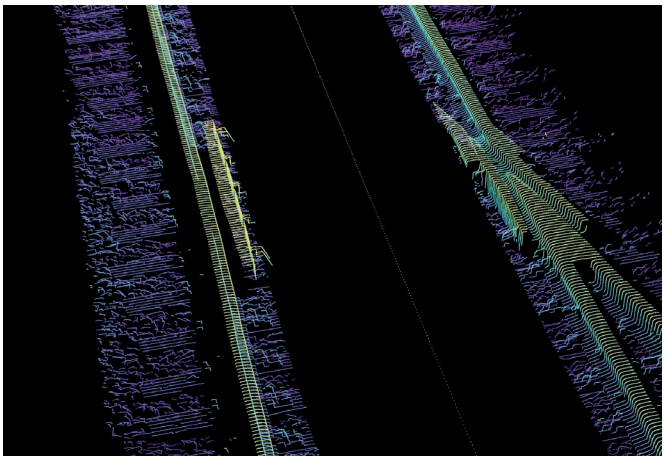
The TGM is based on the light section method, which is an optical 3D measurement technique for sheet beam projection. In this method, a laser projects a line across the entire width of a rail. Cameras record the beam from a spatially offset angle and "see" the optical distortion of the laser line caused by the object's surface. Using the principle of triangulation, the 3D coordinates of the points on a single laser line can be calculated based on the geometric position of the laser and the cameras. As the measuring train moves forward, many individual light sections are recorded, creating a detailed elevation profile of the track.

Railroad measurement systems
by Fraunhofer IPM

Fraunhofer IPM develops optical measurement systems for monitoring and mapping rail infrastructure. Experts in optics, system designers, and electrical and software engineers work together to supply turnkey solutions for the special requirements of infrastructure operators, planners, and providers of surveying services. The robust measurement systems are used around the world and are characterized by their speed, precision, and reliability.



The TGM underneath a measuring train: Cameras record the laser line traversing the tracks.



As the train moves forward, a detailed 3D elevation profile of the track environment is generated in the form of a 3D point cloud.

Compact, robust, and eye-safe

The TGM is installed underneath the surveying vehicle. The sensors are arranged transversely to the direction of travel and firmly mounted on the vehicle frame. The center of the track and the angle of the vehicle relative to the track plane normal are calculated based on the light section measurements. Despite the relatively large measuring distances, the light section cameras enable very high profile rates paired with excellent accuracy and high resolution. Thanks to its wide dynamic range, the system can measure rail surfaces with varying reflectivity, from dark to highly reflective. Pulsed line lasers are used for illumination. Protective funnels ensure compliance with the prescribed nominal ocular hazard distance (NOHD) and prevent contamination of the outlet windows.

Perfectly coordinated measuring systems

The TGM's measurement data is referenced to the center of the track and can be used both for status assessment and for recording the rolling motion of the measuring train. Measurement data from all other systems used on the train can then be adjusted to account for the rolling motion. Fraunhofer IPM customizes the TGM, combining it with other measuring systems, to determine the position and wear of contact wires, as well as the position of poles. This ensures the perfect coordination of hardware and data evaluation. All measuring systems are adapted to country-specific requirements. The service also includes system maintenance and staff training.

Technical specifications

Measuring principle	Light section method
Data recording rate	
Profiles (maximum)	Up to 7000/s
Individual points (maximum)	approx. 17,9 million pts/s
Resolution (traverse to the direction of travel)	2,560 pts/sensor
Distance resolution	Approx. 50 µm
Active illumination	By line laser
Profile density	One profile every 5 mm at 120 km/h

All specifications and features are subject to modification without notice.

Contact

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