🏠 **Directory**

< Infrastructure

LiveEO GmbH

Better from Above: How Satellites Revolutionize Track Maintenance

A revolution of sorts is taking place in Earth observation. The number of satellites in orbit is going to increase from about 8,000 to 57,000 by 2029. Along with this expansion comes a massive increase in higher-quality data, leading to new use cases for satellite imagery analysis. One of those use cases is identifying threats to linear infrastructure, including vegetation encroachment and ground deformation.

Vegetation around infrastructure networks, such as railway tracks, can cause severe problems for operations. Equally concerning are ground movements, with landslides or even derailments the result.

Traditionally, networks dealt with these risks by hiring individuals to perform manual inspections of the track. This demands both significant time and staffing, resulting in much higher costs for operating. Satellite-based monitoring provides high-frequency overviews of the entire network along with actionable insights for segments that demand immediate attention.

Satellite Data & AI-Powered Vegetation Management Make a Difference

LiveEO analyses vegetation encroachment to railway tracks using satellite data. The approach makes grid-wide up-to-date overviews of vegetation risk along the asset a reality.

The company has developed a vegetation classification system based on state-of-the-art artificial intelligence, which enables the continuous updating of satellite data to monitor vegetation and provide a better assessment of risk. The insights are directly accessible through LiveEO's web and mobile app.

As a result, in many cases, networks no longer require manual, on-site inspections,

depending on the software's risk assessment. What was once monitored on foot, by car, or even helicopter can now be recorded and viewed from space. The data used for railway monitoring features spatial resolutions down to the sub-metre range.

The distance between vegetation and the assets is determinable through satellite data analysis. So too are multiple other parameters, all of which improve the risk classification—even the height of trees or even trees outside of the right-of-way are captured. Satellite analysis can also determine healthy trees vs. sick trees. High-resolution and multispectral data allow the system to identify different vegetation species.

Condition-based vegetation management supports the careful removal of trees that present a risk to the operability of any network. Despite this, climate change is unpredictable, and the severity of storms will likely increase vegetation falling into the right-of-way.

The accuracy of LiveEO's solution has been validated on field trips repeatedly © LiveEO GmbH

From Satellite to Ground Worker

The process from automated data acquisition to the provision of the results is visualised in this image:

Satellite Data Artificial Intelligence Critical Grid User Interface Tasks and Overview
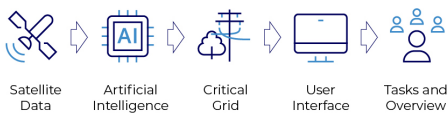
The process from data acquisition to vegetation managers and task execution

The continually updated satellite data is downloaded via API from various satellite constellation operators and combined in a database. There, artificial intelligence does the vegetation classification and performs an automated risk assessment of the data. Based on the risk assessment, the software automatically generates maintenance and inspection tasks and prioritises them.

A web application or mobile app is then used by supervisors and on-site personnel to efficiently access the information and plan work. The in-depth risk assessment makes it easier to prioritise the right tasks. The system goes beyond analytics and allows work orders, which are automatically generated based on the risk assessment, to be assigned directly to the appropriate staff members or subcontractors. Making the switch to satellite-based vegetation monitoring improves the efficiency and transparency of the vegetation management process. Savings in operational costs have been reported to be up to 30%.

Ground Deformation Detection

Detection of ground deformation is another important application of satellite analysis for railway operators. Ground deformation is not visible to the naked eye but can cause significant damage to railway tracks and even lead to derailments. Even slight elevation changes can be the first sign of seriously concerning events such as dam failures or landslides.

Most research indicates that half of all train derailments are caused by bent or damaged rails. In the U.S., there are, on average, 3.7 derailments per day. In the EU, there were 68 such derailments in 2016. Not only are these derailments a cause of fiscal concern, but they

> *"Keep in mind, even the most on-site measurements could not map large areas on a similar scale with comparable accuracy."*

also come with an increased risk to passengers.

To combat this problem, LiveEO utilises satellite-supported radar data monitoring. SAR (Synthetic, Aperture, Radar) is the technological means used for this process. It can cover massive areas and pinpoint problems down to millimetres.

The method provides a comprehensive overview of larger areas and can detecting trends to make railways safer and more reliable.

Monitoring 34,000km of Rail Network for Deutsche Bahn

LiveEO has worked with the German railway operator Deutsche Bahn since 2018. Its 34,000 km rail network consists of a dense tree population, which has proven to be an essential factor in passenger and freight traffic operability. Because of a lack of manual solutions to properly analyze the entire network quickly, and a lack of reliable data for determining the appropriate budget, strategy, and personnel management, LiveEO was commissioned to

determine the number of track kilometers directly impacted by trees. Ongoing collaboration with Deutsche Bahn and a detailed field validation campaign enabled LiveEO to increase their training and classification models. The enormous scale of this early client has pushed LiveEO to develop a solution that can handle vegetation classification for networks on a country scale with a high level of accuracy. For their innovative solution, LiveEO has recently been awarded Deutsche Bahn's Supplier Innovation Award 2021.

Outlook

A significant amount of data collected from space now leads to new potentialities for railway network vegetation management. These insights have led to ongoing risk updates for railway tracks through spatial and temporal resolution from satellite data. Increased transparency, improved efficiency in task and personnel management, along with increased organisational security, and better network availability, are all possible thanks to the automation of risk assessment and digitising processes. In the future, more use cases are expected.

The project with Deutsche Bahn has proven that more advancements are on the horizon for vegetation management for rail traffic. An increase in extreme weather conditions has led to more problematic railways. Faster and more efficient hazard tree detections are necessary for the safety and reliability of rail transport.

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Jan Grothe and Dr Richard Lutz of DB AG award Daniel Seidel, LiveEO GmbH, with DB's Supplier Innovation Award 2021