Toward Railway Innovation

Ascent

Railway Technical Research Institute

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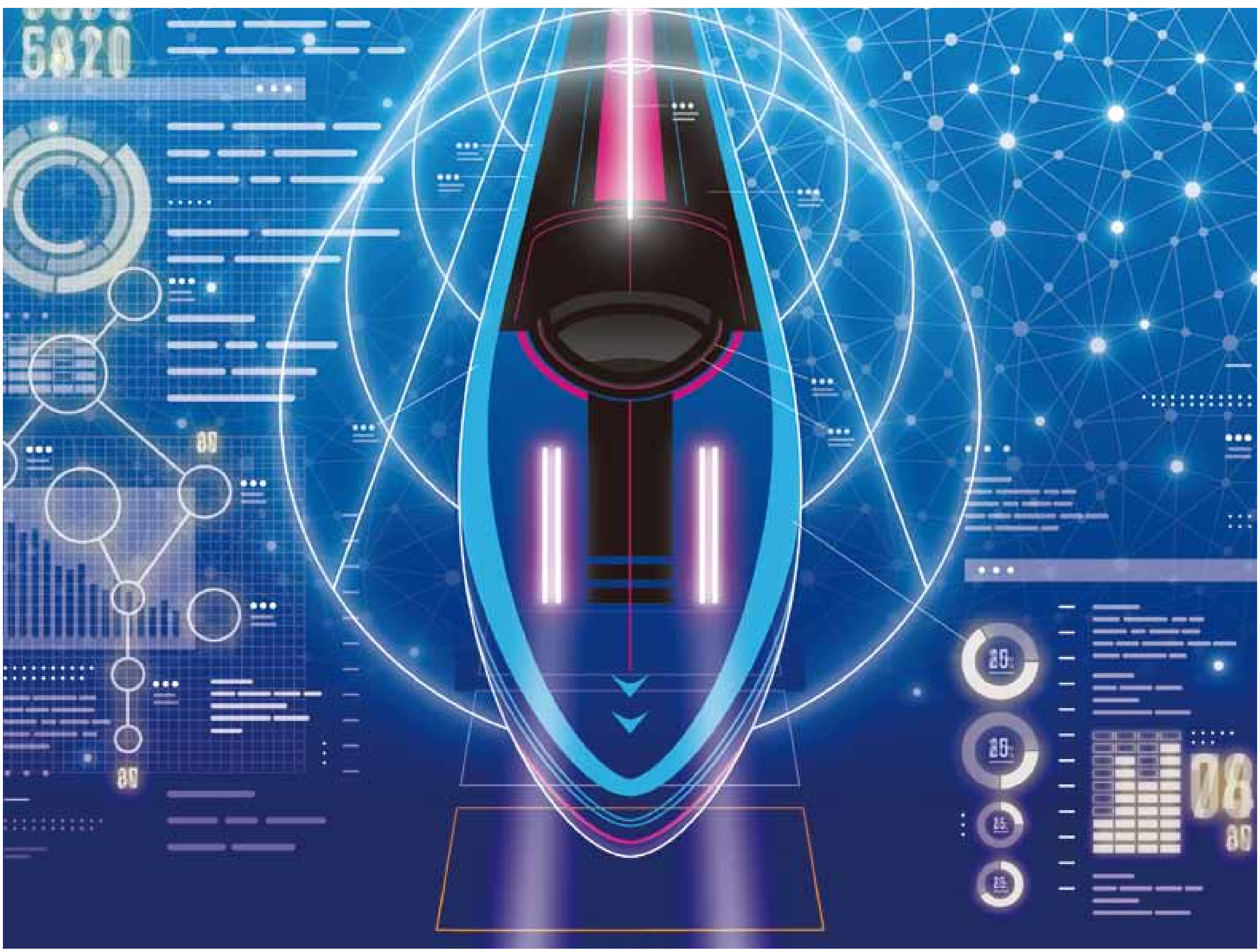
Digitalization in Maintenance

WCRR 2019 TOKYO



Toward Next-Generation Railway Maintenance

Many railways today are focused on the prospect of adopting digital technologies as a key to making their maintenance processes more efficient without compromising their current levels of operational safety. This trend is inevitable since the majority of the operating costs of railways are generated from the maintenance of their assets, including infrastructures and rolling stocks. Reducing their operating costs through more efficient maintenance processes is of vital importance to railways intent on becoming more competitive against each other, as well as other transportation modes, which themselves are gaining strength and competitiveness by benefiting from the rapid progress of digital technologies.

With such a competitive environment in mind, this issue of the *Ascent* magazine features an overview of some of the solutions that RTRI has developed to identify more efficient maintenance processes for railway assets. One important trend in railway maintenance is the adoption of condition-based maintenance strategies, which is expected to revolutionize railway maintenance. Key technologies for this drastic change will be the integration of cutting-edge digital technologies including sensing, wireless communication, artificial intelligence, and big data analysis. Research and development that RTRI is pursuing in the field of railway maintenance is, of course, concentrated in this direction. In addition, this issue includes an article on the efforts of the French National Railway Company, Société nationale des chemins de fer français (SNCF), to apply digital technologies aimed at realizing efficient and effective railway maintenance.

We sincerely hope you will find this issue of *Ascent* interesting and helpful.

Mr. Ryuji Tsuchiya
Managing Editor
(General Director, International Division)

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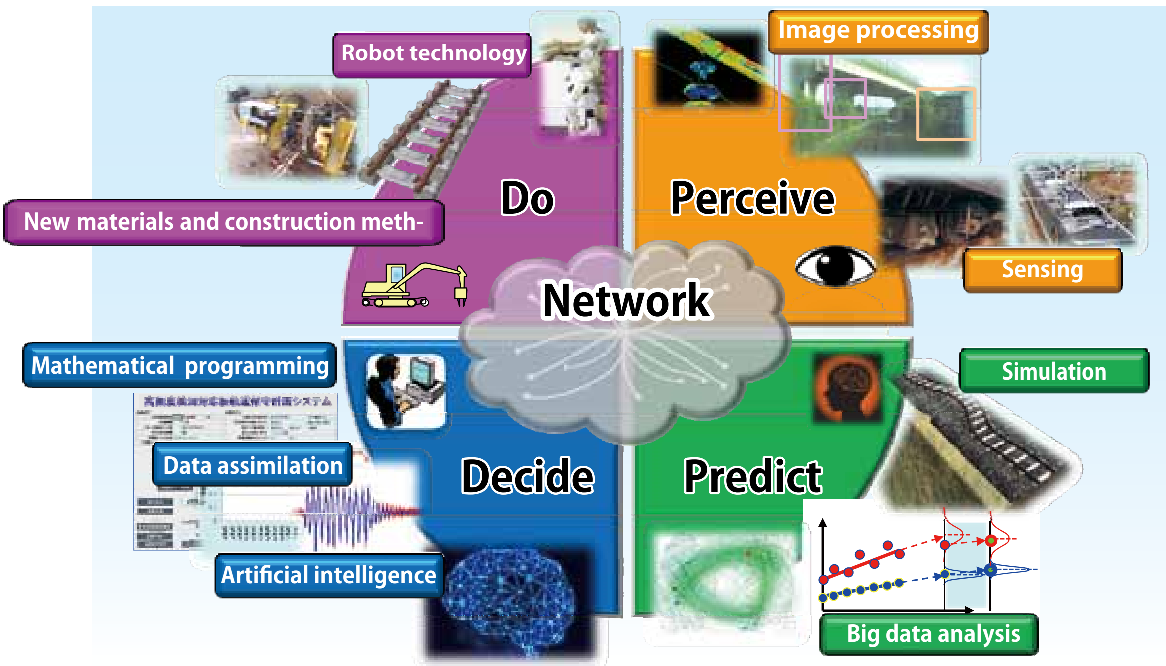
Editor-in-chief	Kimitoshi Ashiya (Executive Director of RTRI)
Managing Editor	Ryuji Tsuchiya (General Director, International Division of RTRI)
Publisher	Railway Technical Research Institute
Address	2-8-38 Hikari-cho, Kokubunji-shi, Tokyo 185-8540, JAPAN
URL	www.rtri.or.jp/eng
Contact us	Public Relations, Railway Technical Research Institute
Mail Address	www-admin@rtri.or.jp

Digital Technologies Will Change Maintenance Work

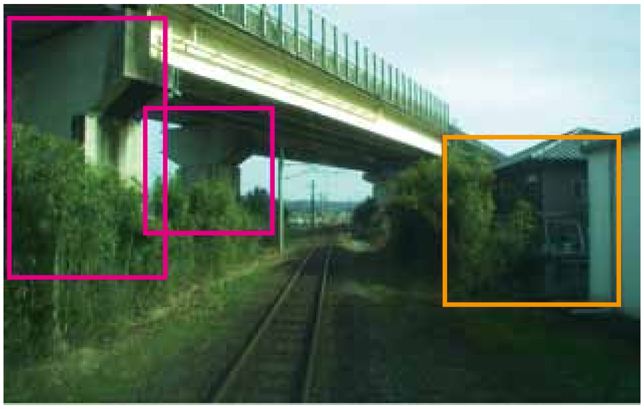


Maintenance upgrading

Dr. Katsumi Muramoto
Director
Head of Track Technology Division

Preface

The issues in maintenance can be separated into three subjects: "labor-saving", "cost reduction", and "quality improvement". Which of the three should be stressed depends on the railway operator and circumstances of the country. In a country where there is declining birthrate and aging population, "labor-saving" is promoted in preparation for future shortage of maintenance personnel. For a regional railway with a low transport revenue, however, "cost reduction" may take precedence. In a developing country where serious railway accidents still frequently occur, "quality improvement" of maintenance is an urgent issue. In Japan, the issue was "quality improvement" of maintenance at first because it was directly linked to safety. After privatization of JNR, the priority issue became "cost reduction" for sound management, and then "labor saving" in recent years when the declining birthrate and aging population have become serious concerns. Of course, all the issues are still under research and development performed by RTRI. Moreover, using ICT (Information & Communication Technology) that has been developing rapidly in recent years may make it possible to upgrade railway maintenance and solve all the three issues at once.



Wayside obstacles

Public (persons and cars)

Automatic extraction of hazards in the environment surrounding tracks

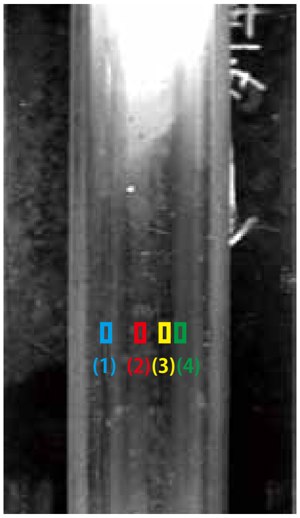
Maintenance upgrading and digital technologies

Upgrading of maintenance refers to

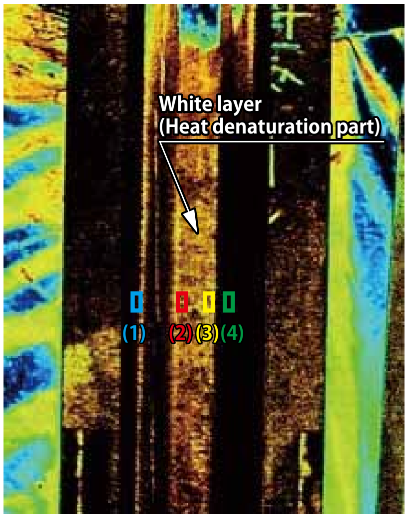
1) Digitizing all the maintenance information,
2) Classifying the maintenance into four phases: "Perceive," "Predict," "Decide," and "Do", and automating and sophisticating these phases using ICT, and
3) Exchanging maintenance information between phases over the network, as close to real-time as possible.

The most important thing in this case is that all the maintenance information is digitized, which means that the "Perceive" phase for acquiring information is the most important.

So far, dynamic sensors, such as displacement gauges and load meters, are commonly used to obtain maintenance information. However, subjective information from human visual inspection can now be easily digitized using a combination of image processing, machine learning, etc. Therefore, RTRI is focusing on image-based sensing to upgrade the "Perceive" phase. At present, RTRI is developing basic image sensing technologies, such as those for automatically extracting hazards in the environment surrounding tracks, and identifying the state of rail deterioration from the spectral information in images.



Rail image

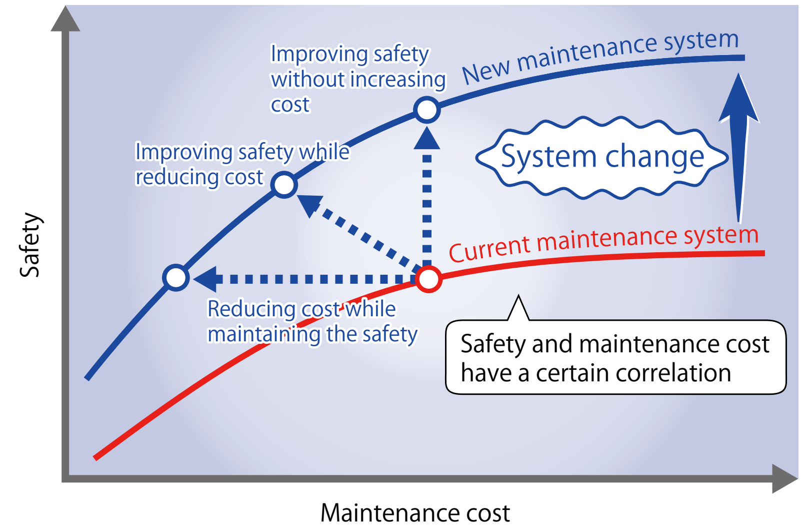


Spectral analysis image

Rail deterioration judgment through image spectral analysis

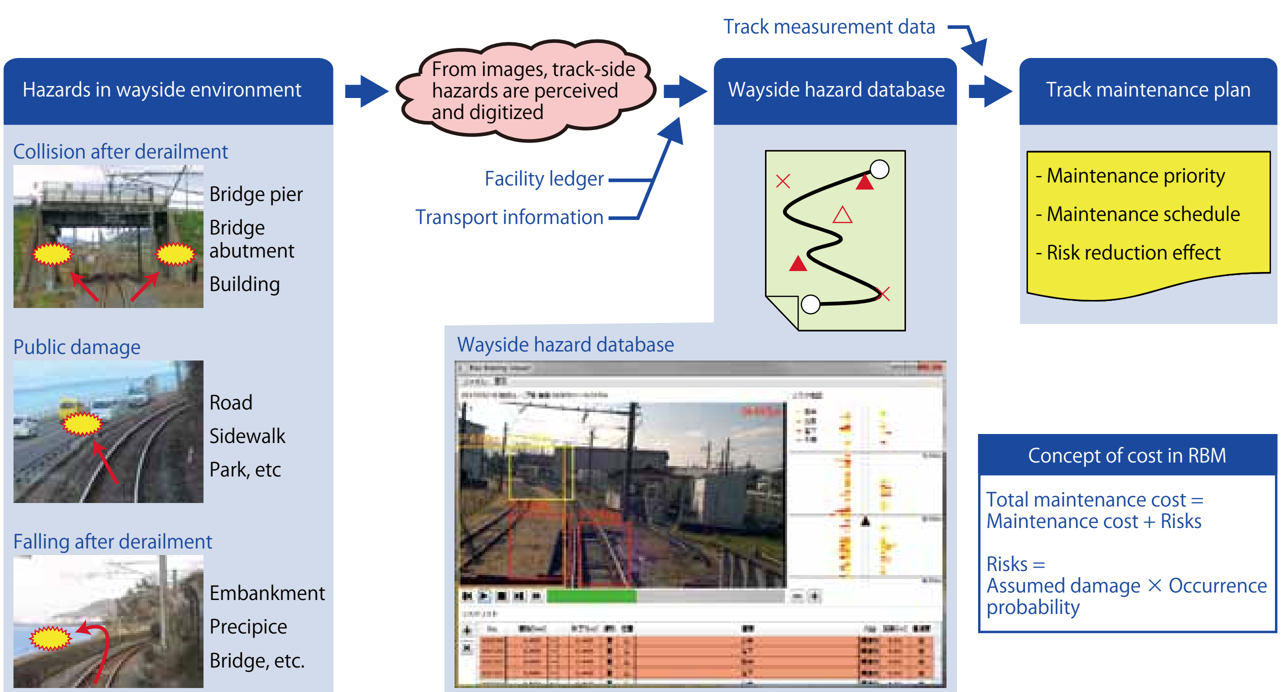
Maintenance system changes

Maintenance upgrading will accelerate the solution of the issues of "labor-saving", "cost reduction", and "quality improvement" in the current maintenance system. However, these issues have factors contradictory to each other, and it is sometimes difficult to solve them simultaneously in a single maintenance system. There is obviously a certain correlation between safety and maintenance cost. As cost reduction is promoted, lowering of safety to a certain degree may sometimes be tolerated. Although circumstances differ between railway operators, the ideal is to reduce cost without sacrificing safety. This requires changes in the maintenance system, i.e., "system changes".



Safety and maintenance cost

RTRI is investigating RBM (Risk Based Maintenance) in which the total maintenance cost is obtained by adding the maintenance cost to risks that are calculated on the assumption of post-accident scenarios from railway hazards. RBM, when combined with CBM (Condition Based Maintenance), may achieve safety improvement and cost reduction simultaneously. When realized, it will bring about drastic system changes in track maintenance.



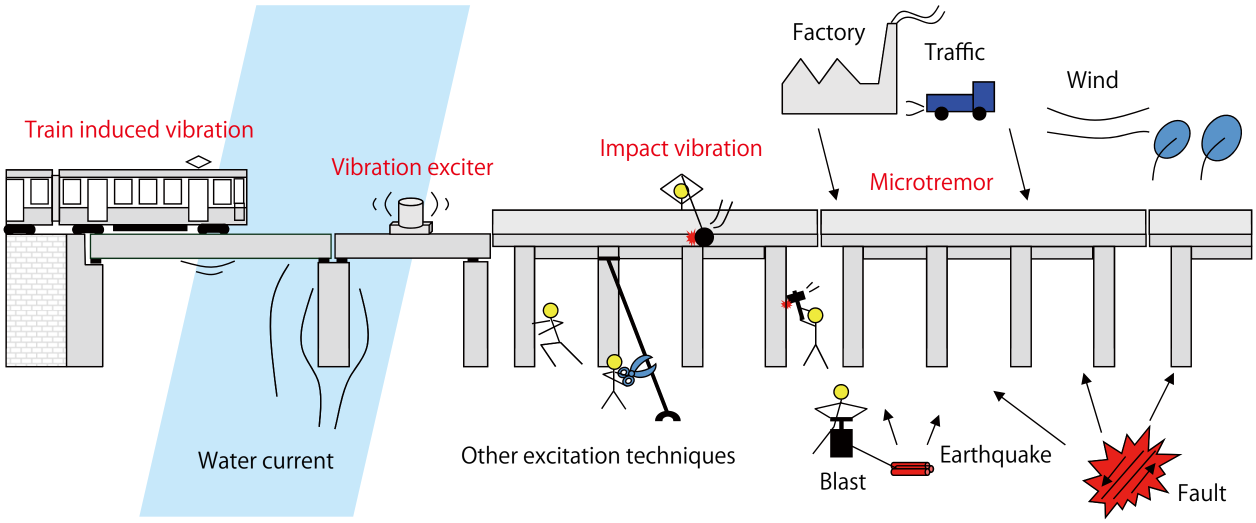
Risk Base Maintenance (RBM) on tracks

Observing Vibrations from 300 m to Diagnose Infrastructure Deterioration

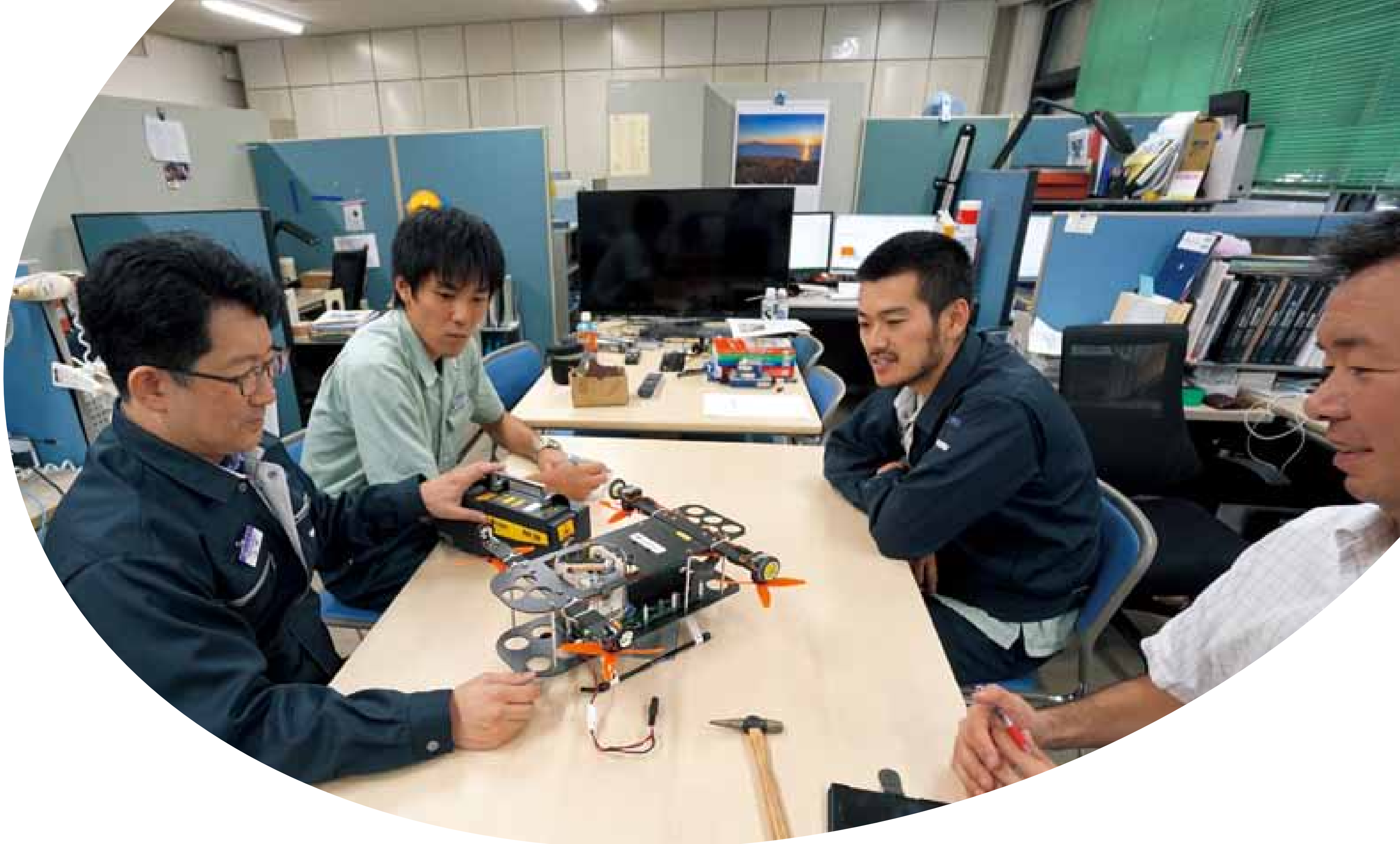
Dr. Fumiaki Uehan
Director
Head of Railway Dynamics Division

The ageing of existing railway facilities, including bridges, and of the workers who inspect them is increasingly calling for more efficient and safer inspection methods. With this in mind, RTRI developed the Long-range U-Doppler by improving the U-Doppler. U-Doppler is a noncontact vibration measurement system for diagnosis of structures developed earlier by RTRI and already being used in practical applications. The Long-range U-Doppler enables inspection of railway bridges without the need for scaffolding. It detects not only changes in bridge behavior with deteriorating health but also harmful changes in condition.

The railway industry has a long history of studying techniques to inspect structures by measuring the vibration induced by passing trains and other sources. Some of these techniques have been released for practical applications. The amplitude and natural frequency of vibration of structures are functions of a number of factors including deterioration in strength, damage caused by earthquakes, and bearing capacity reduced by swollen rivers. Structures can be evaluated for the extent of damage and deterioration by comparing their vibration data with corresponding parameters measured in a healthy state, their design reference values, or statistically or analytically calculated reference values. The vibration can be caused by artificial excitation, such as from passing trains and impacts from a weight, and by microtremors and other vibration sources.



Sources of vibration for inspection of structures



The conventional method of vibration measurement requires many hours spent on the installation and removal of sensors, recorders, connection cables and other items. It occasionally involves work high above the ground, near tracks, and in other hazardous places. For these reasons, RTRI studied the possibility of developing noncontact, remote techniques for measuring the vibration of structures.

As part of the effort, RTRI improved a Laser Doppler Velocimeter (LDV), a noncontact vibration sensor, by making it usable for the outdoor measurement of large structures. One of the key features of the system is a technology that compensates for the vibration of the LDV sensor itself caused by external disturbances such as wind and ground motion. Hence the name "U-Doppler" (Undisturbed laser DOPPLER velocimeter), with the "U" standing for "Undisturbed" by external disturbances.

The U-Doppler beams a laser at structures several dozen meters away to measure their vibration. It is mostly used to measure the vibration (strain) of bridges during the passage of trains and the natural frequencies of viaducts and piers. The U-Doppler eliminates the need to install sensors at high and otherwise hazardous places, making structure inspection involving vibration measurement more efficient and safer. The U-Doppler I, which was released in 2007 for application to practical purposes, has since been used for inspection of a range of structures along railway lines. In 2016, the U-Doppler II was developed, which is smaller and lighter than the U-Doppler and can communicate by radio.

The U-Doppler, which is mostly used for the measurement of railway bridge strain and viaduct natural frequency, has a relatively short range (10 m to 30 m). However, a measurement range of a few hundred meters is typically required for the inspection of long bridges, long sequences of viaducts and other long structures.

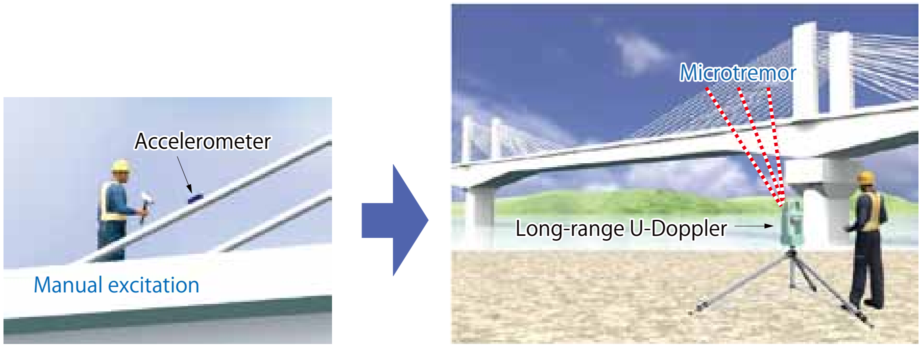
To meet this requirement, the Long-range U-Doppler was developed, which uses an invisible light laser in place of the red laser that is used on the U-Doppler. The invisible light laser is less harmful to the eyes and has a higher output power with the same level of safety as before. In addition, the Long-range U-Doppler automatically detects remote targets and searches for, and automatically sights on, spots on well-reflective targets and are suitable for remote noncontact measurement. With all these improvements combined, the

Long-range U-Doppler

Long-range U-Doppler offers a noncontact measurement range of non-reflective targets that is more than ten times longer than that of the U-Doppler. It enables noncontact measurement of targets a few hundred meters away without the installation of reflectors on the structure being measured.

The cables on long cable-stayed bridges need to be monitored and maintained at the correct tension. Currently, cable tension is estimated by hitting the cable with a hammer, measuring the vibration caused using a vibrometer installed on the cable and analyzing the measurement. The Long-range U-Doppler remotely sights on the cables one by one and measures microtremors to estimate the cable tension without any manual excitation. Inspection of a cable-stayed bridge is typically conducted during night hours over four days with the conventional method. With the Long-range U-Doppler, the same amount of inspection can be completed in approximately one hour during the daytime with measurement accuracy equivalent to that of the conventional method.

Part of the study presented in this paper was subsidized by the Ministry of Land, Infrastructure, Transport and Tourism.



Conventional cable vibration measurement

Remote noncontact measurement

Change of vibration measurement method of cable-stayed bridge cables

Commercial Trains Check Tracks Daily to Collect Data for Maintenance Planning

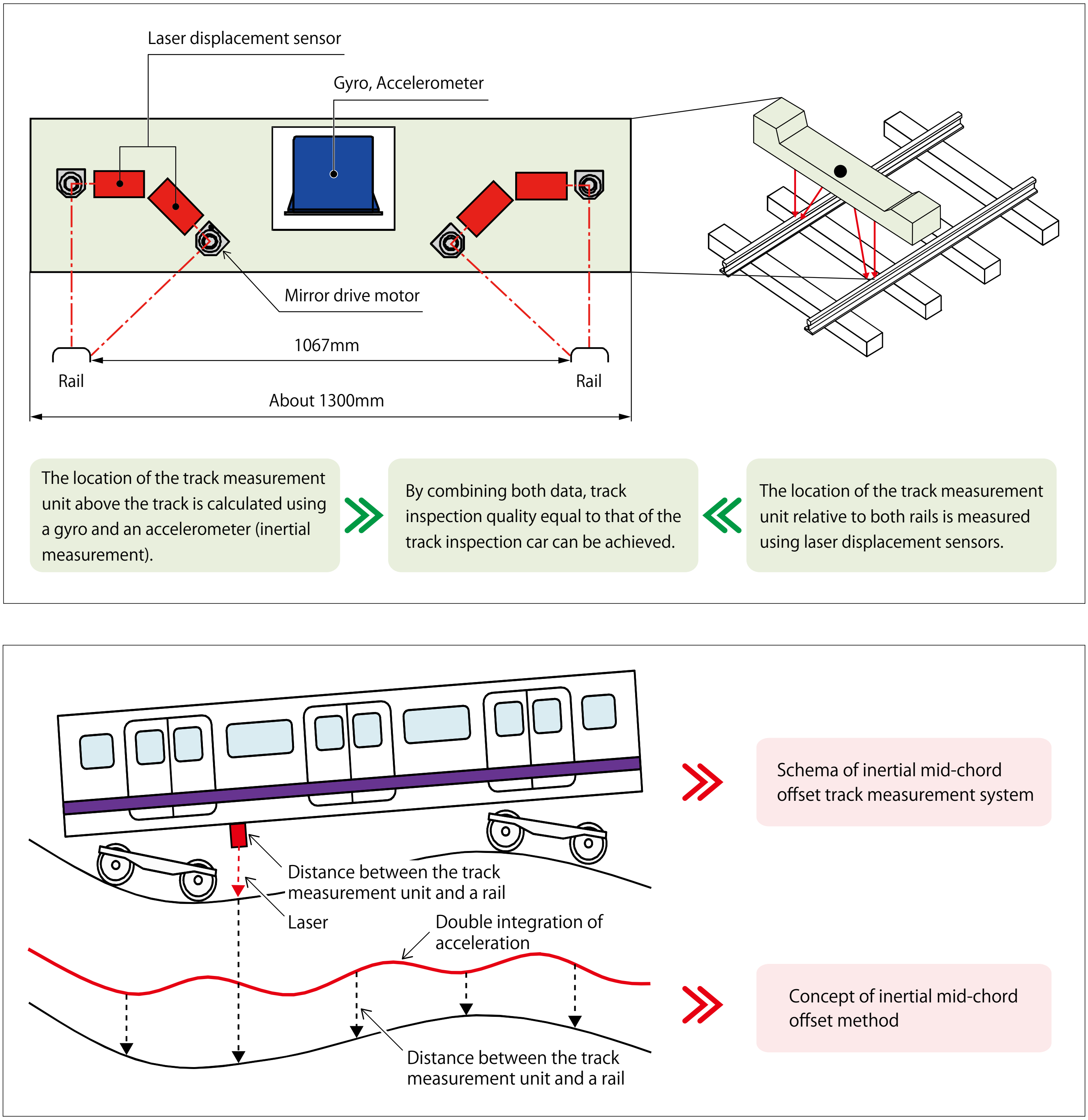
Mr. Yosuke Tsubokawa
Senior Researcher
Track Geometry and Maintenance

Mr. Hirofumi Tanaka
Senior Researcher
Track Geometry and Maintenance

To maintain and improve the running safety and ride comfort of railway vehicles, railway operators regularly measure track geometry (vertical and lateral irregularities, rail surface twist, etc.) using track inspection cars and schedule track maintenance based on the results. Currently, track geometry inspection is conducted about every three months for conventional lines and about every ten days for Shinkansen lines. The data gathered is used for subsequent condition-based maintenance (CBM). Today, with the anticipated reduction in rail transport revenues and shortage of skilled engineers, CBM needs to evolve from the current system of periodic inspection into a more efficient one built on more frequent inspection and higher accuracy. To meet this requirement, RTRI has developed an inertial mid-chord offset track measurement device that can be mounted on commercial trains to enable daily track inspection. RTRI also developed a method for processing the data gathered at high frequency by the device for effective maintenance planning. These developments are outlined below.

Bogie-mounted track measurement device   Car body-mounted track measurement device

Location of the inertial mid-chord offset track measurement device on the commercial vehicle for each mount type



Track inspection using the inertial mid-chord offset method

Mr. Tsubokawa, senior researcher, working in front of an inertial mid-chord offset track measurement device

Inertial mid-chord offset track measurement device

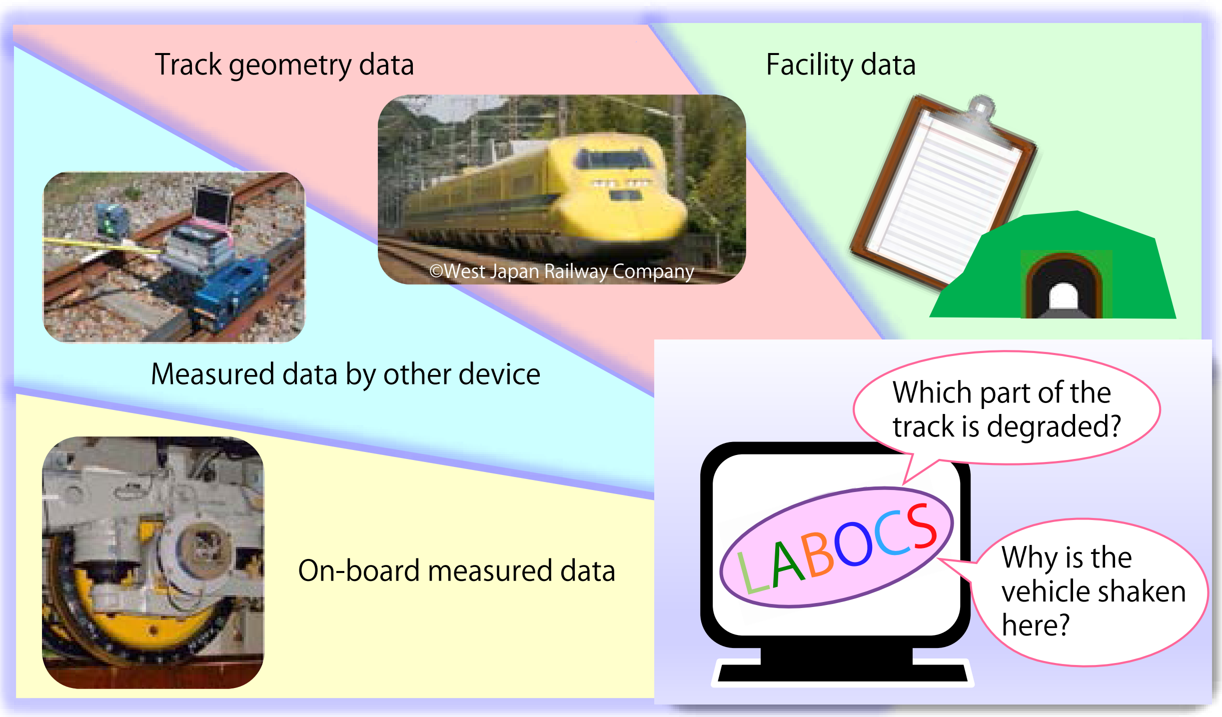
The inertial mid-chord offset track measurement device consists of a track measurement unit that houses a gyro, an accelerometer, laser displacement sensors and other items, and a control box. It is installed either on the bogie or under the floor of a commercial vehicle to measure the tracks at high frequency, thus it doesn't make track inspection cars indispensable. The device is based on the inertial mid-chord offset method that uses a basic principle of physics, which is: double integration of acceleration is equal to displacement. Applying this principle generally increases the amplification factor in the low-frequency range where the acceleration is low. This prevents accurate geometry measurement of tracks with long wavelengths such as in curve sections.

To address that issue, the inertial mid-chord offset method combines its measurement characteristics with those of the 10 m-chord versine method, which is commonly used in Japan for track irregularity control, to process acceleration and thereby achieve track inspection quality equal to that of conventional methods. The location of the track measurement unit above the track is calculated using the gyro and accelerometer. While at the same time the unit's location relative to both rails is measured using the laser displacement sensors. Then, based on this data, track irregularity is calculated.

Processing of high-frequency track measurement data by LABOCS

LABOCS, a database system developed by RTRI, is designed exclusively to process track measurement data with its extensive signal processing functions. LABOCS analyzes track measurement data for proper track maintenance after putting the data through position synchronization. It is capable of processing not only distance-based track measurement data but also data gathered by various other devices including time-based acceleration due to oscillation and ledger data after converting them into distance-based data. In addition to position synchronization, LABOCS offers a range of distance- and time-based filters.

Currently, a total of 500 LABOCS licenses are owned by more than 25 railway operators and other rail-related companies in Japan and abroad, who have been utilizing the system to secure the running safety and ride comfort of their vehicles

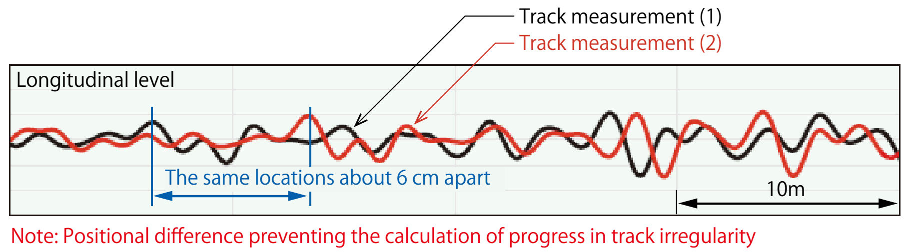


Rendition of LABOCS functions

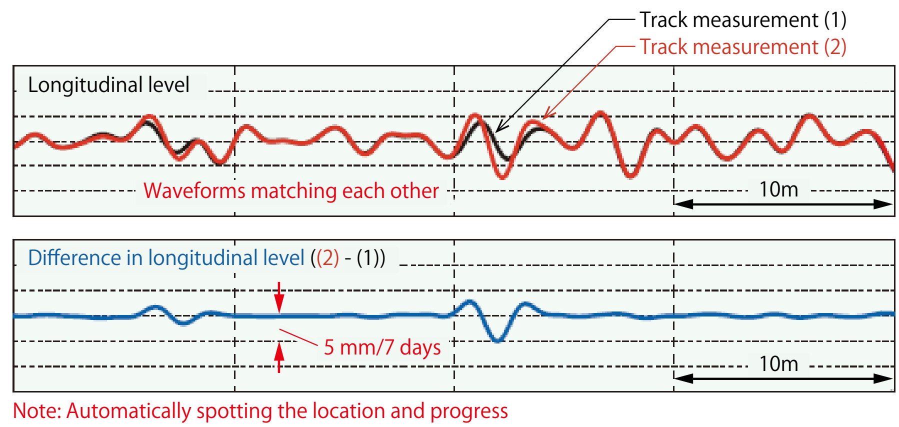
through proper control of track irregularity. LABOCS is also capable of processing track irregularity waveforms for not only Japan's chord-versine control but also Europe's wavelength band control.

Track inspection cars run over the same section regularly, and it can be extremely difficult to synchronize the section's cumulative data with that measured in past runs. This is because the car's steel wheels can slip and slide on the steel rails on which they run. Similarly, for high-frequency track measurement by commercial trains, which often run the same section many times daily, to yield useful data for track maintenance, automated and highly accurate data synchronization is a must. All this suggests that, if a highly accurate synchronization system was available, it would be possible to automatically spot where on the tracks irregularity were growing rapidly.

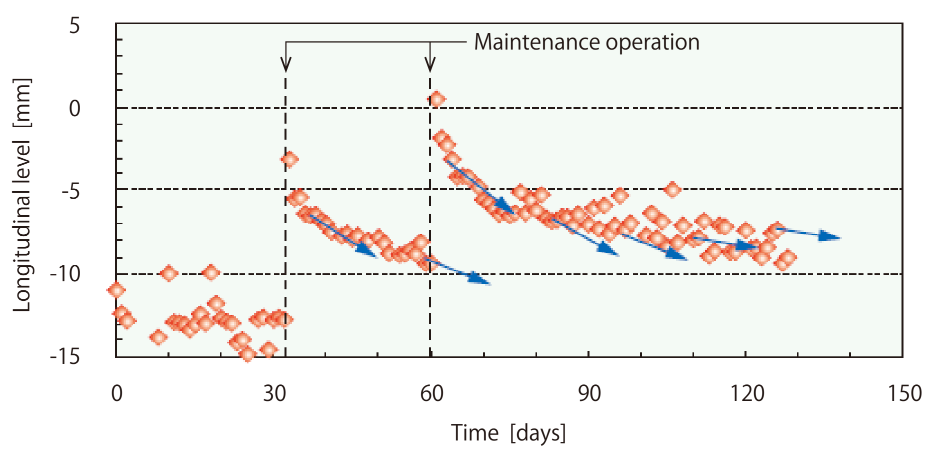
For these reasons, RTRI developed a waveform matching technology and incorporated it into LABOCS. As a result, LABOCS is now capable of automatically spotting locations of rapid growth in track



Example of out-of-sync track irregularity waveforms obtained by conventional methods



Highly accurate synchronization of track irregularity waveforms and calculation of irregularity progress based on the new (cross correlation) method



Example of Bayesian estimation of progress in track irregularity

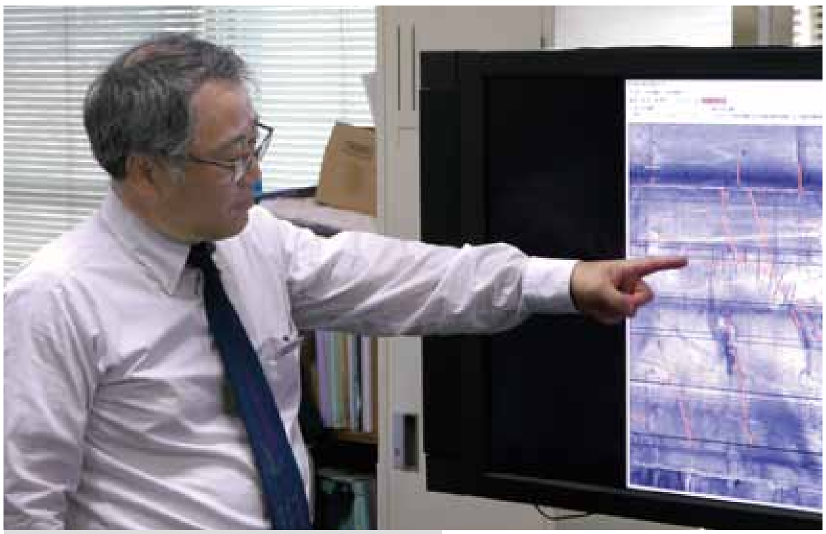
Mr. Tanaka, senior researcher, viewing LABOCS charts on a PC

irregularities. Also being developed is a method for predicting the growth in track irregularity over the short term based on data measured daily and updated regularly. Each arrow in the figure shows predicted growth in track irregularity based on the data measured and updated up to that point in time. These methods for spotting and predicting locations of rapid growth in track irregularity are already being used by JR East to plan track maintenance on its conventional lines. Armed with these features, the system enable
s the maintenance staff to predict when and where track irregularity will reach the target or standard value and thereby to plan and execute track maintenance accordingly. Using the system, it is also possible to check the quality and effect of the track maintenance done, bringing us closer than ever to highly accurate CBM of track irregularity.

Future plans

In Japan, track measurement is still mostly conducted on a regular basis using inspection cars. For more efficient track maintenance going forward however, commercial trains are expected to replace inspection cars as the main means of track measurement. Accordingly, RTRI will continue to enthusiastically develop track inspection and related data processing technologies to help further upgrade track maintenance operation. Through these R&D efforts, RTRI will support railway operators in transforming the current track maintenance into a highly accurate system based on CBM.

Deep Learning Finds Tunnel Cracks



Mr. Masato Ukai
Senior Chief Researcher
Head of Image Analysis and IT Laboratory

Introduction

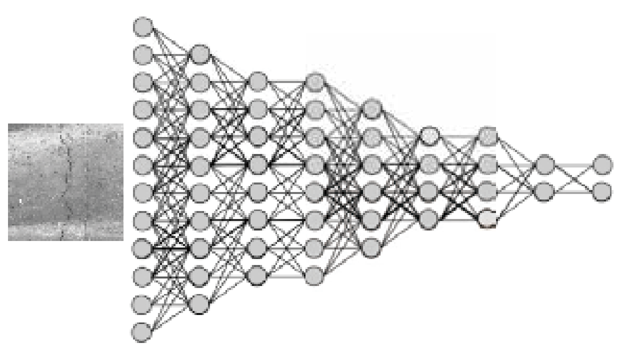
Since maintenance and inspection services for railway structures depend on visual inspection, we have inherent problems in terms of work efficiency and accuracy of inspection. In the efforts to find a solution to these problems, image processing technologies are being highly anticipated to be practically implemented in maintenance and inspection services as soon as possible as an alternative to visual inspection.

So far, RTRI has proposed methods to detect cracks and other deformation based on shading and contours observed in a target image. However, the approach taken in such development efforts is basically a trial and error process to find an optimum algorithm, which is based on experience. To overcome this issue, deep learning might be applied to detect cracks, which is recently attracting much attention. By combining deep learning with the image analysis techniques so far developed, an improved method could be developed that can provide a crack detection capability comparable to that of human judgment.

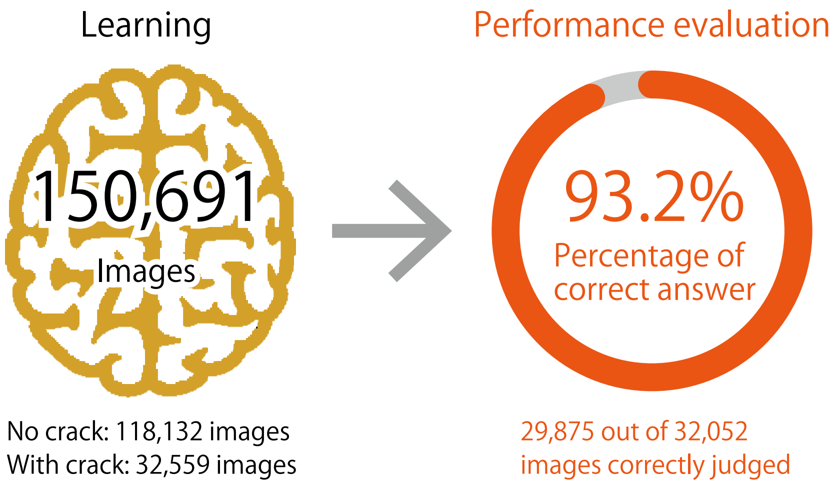
Overview of the proposed method

In conventional image processing programs, it takes significant effort and know-how to adjust the parameters. In addition, it is difficult in image processing to remove noise images, such as those of cables and joints, that look like cracks. A deep learning structure with multiple intermediate layers of the neural network is, thus, applied to create a discriminator that can determine the presence of cracks in each area.

This method mainly consists of "learning" and "deduction" processes. In the learning process, a large number of labeled images are iteratively studied to find out specific characteristics such as regularities and common patterns to eventually create an identification model. To provide training data for the learning process, a tunnel lining surface is meshed and classified each mesh segment (cell) into either "crack (with cracks)" or "none (no cracks)," according to the presence of crack. Any cell that contains a cable or joint, or both, was classified as



Deep learning is a machine learning method using deep neural network which consists of multiple layers between the input and output layers.

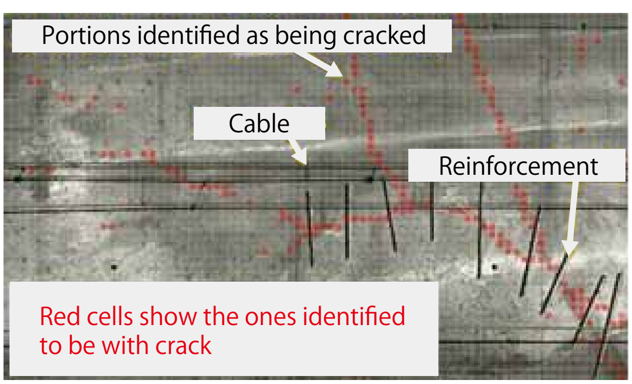


Evaluation of correct answer rate with verification images

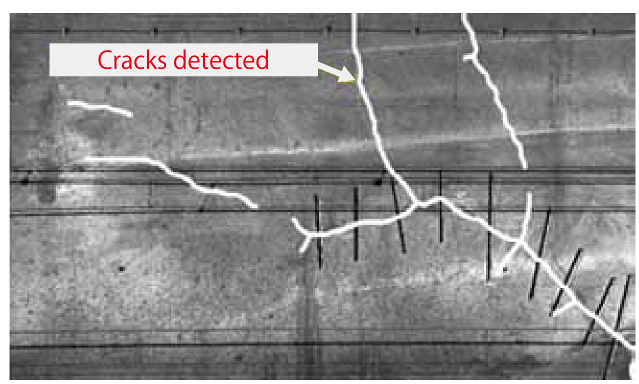
"none". Several tens of thousands of mesh segment images are prepared for each class as training data. In the deduction process, entering an unknown image to the identification model established through the learning process produces a deduction result in the form of a probability score for the labeled image. Accordingly, the computer is now able to automatically acquire an amount of characteristic through autonomous data analysis without requiring any explicit programming by humans. Our experimental results showed that the presence of cracks was correctly answered for more than 90 % cases.

Detailed image analysis to supplement the results of deduction

To use the detection results more practically, a hybrid crack detection method is proposed to perform detailed analysis on a gray-scaled image, where the pixel value corresponds to the probability of crack presence. In this method, a bit map image is created, with each pixel value of 0 to 255 linearly corresponding to the crack presence probability of 0 to 1. The image is then analyzed to determine the position and direction of cracks. As cracks tend to be connected in the direction of the principal axis, after performing an expanding process and connecting near-by line segments any line segment of less than a certain length is removed. Then, the remaining areas are contracted, smoothed, and skeleton extraction is made to finally detect cracks. It allows to show that the cracks behind cables and other ancillary items are correctly detected. Comparing a manually drawn deformation map with the detection results obtained from the proposed method for the same area, this detection method is practical since its results are comparable to those from human judgment.



Crack presence identified by deep learning

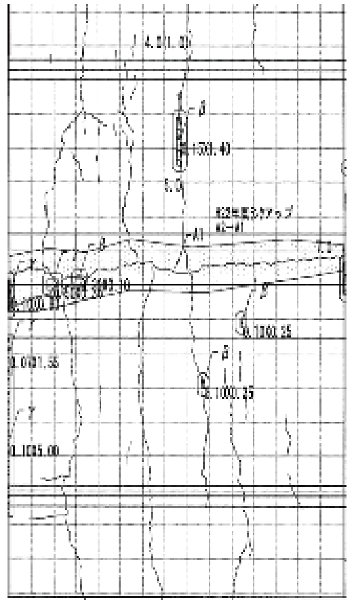


Eventual crack detection results after detailed image analysis on the identification results to the left

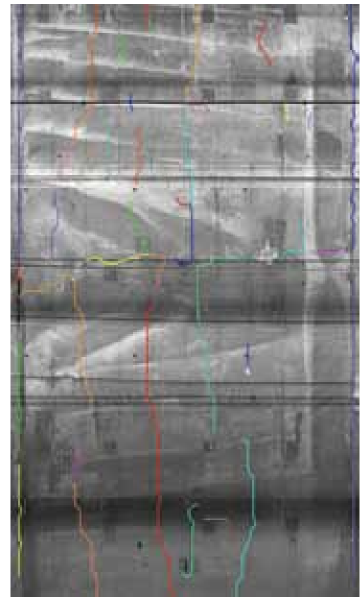
Future R & D approach

The performance of the proposed crack detection method is planned to further improve as one of the essential elemental technologies to realize automatic creation of deformation maps as well as to deal with other disturbances such as water leaks.

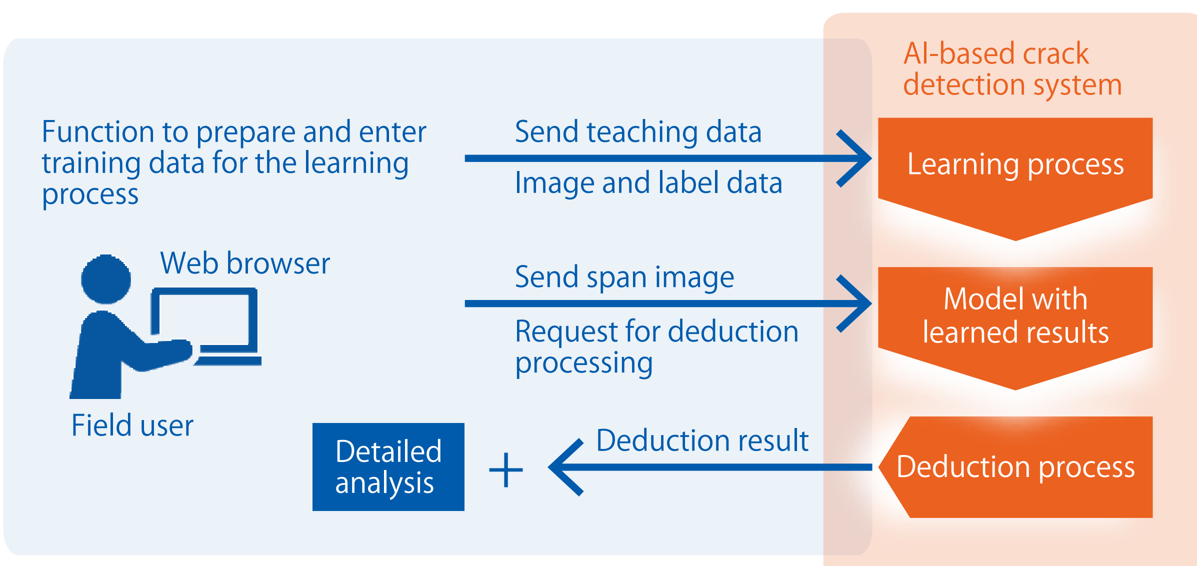
While the final goal of this study is to implement this method for practical use in tunnel maintenance and inspection services, our present target is to realize a trial use in the field, as a necessary step, to also enhance the sense of speed in the entire research and development activity. This system is continuously improved by receiving feedback on the usability and other comments from the field. To be more specific, the program will be released on the Web to make it publicly available so that field engineers can use a cloud-based AI system to analyze the images of tunnel lining surface taken from various locations and detect cracks. The user client program will have the functions to prepare and input training data for learning, perform detailed analysis, perform relearning, and be customizable to the user's needs.



Manually drawn conventional deformation map



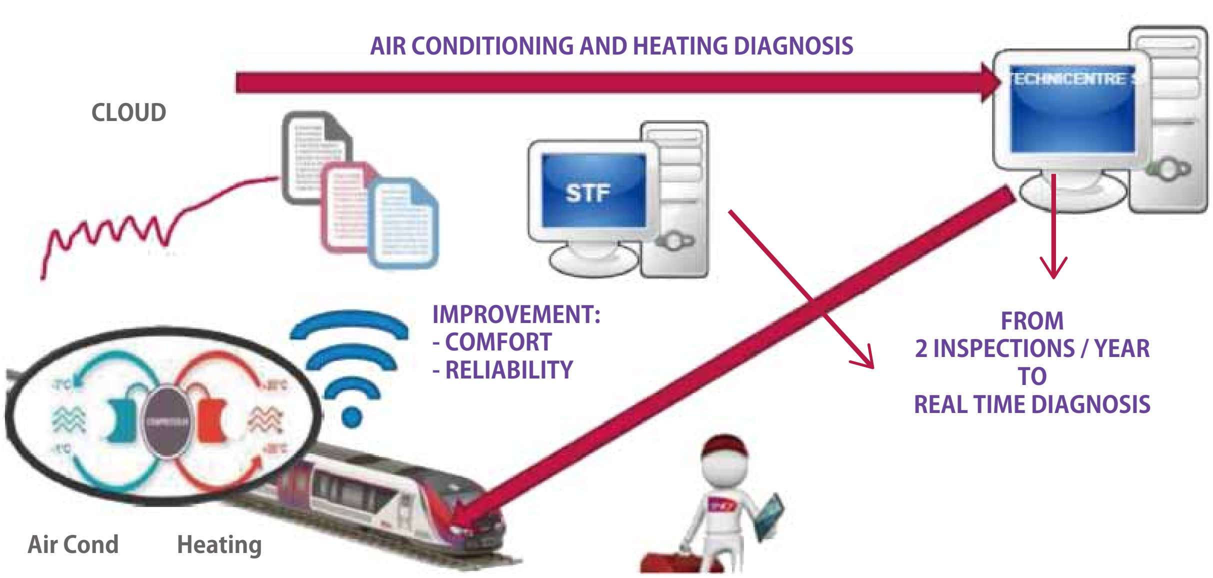
Cracks detected by the proposed method



Users to use cloud services

Internal server, commercial cloud, etc.

Digitalization in Maintenance at SNCF



Real time automated monitoring

Mr. Valéry Versailles
Head of department
Railway System Innovation & Research
SNCF

Railway is an old industry that has continuously improved for more than 100 Years. High level research have been conducted and are still underway as seen during last WCRR in 2016 in Milan and as we will for sure see at the next WCRR in 2019 in Tokyo. After all, there are still huge challenges to be addressed due to traffic congestion, climate changes and resources scarcity. Recent improvements in digital technologies allow now to make not only additional basic improvements but to be a game changer in the way railway systems are built, operated and maintained. At SNCF, one of our current concerns is to take the opportunity of digital technologies to drastically improve the maintenance of the assets, i.e. rolling stock, infrastructure and stations.

The challenges for the French railway maintenance can be summed up in three points:

- Permanently guarantee a very high level of safety and service for travellers
- Guaranty the availability of the assets in daily operations
- Pursue the endless quest for productivity, given the rail industry has intrinsically high fixed production costs.

We are now able to address these challenges thanks to recent and on-going developments of digital technologies such as Internet of Things, Artificial Intelligence, Machine Learning, Augmented Reality, Big Data, Cloud Based Technologies, Automation and Robotics, Digital Twins, GPS, RFID.

Here is how SNCF create value thanks to those technologies:

First, SNCF has integrated predictive maintenance in its process of digital transformation. The approach consists in collecting data of assets thanks for instance to IoT, drones, or satellites and makes a smart analysis of them to set up an alert system to prevent failures. Moreover, predictive maintenance aims to automate these tasks in order to have a real time precise and complete vision of the state of the assets. By using machine learning, the system is trained to learn trains, infrastructure or stations failures scenarios by crossing various types of data.

On a daily basis, SNCF performs real-time remote and automated diagnosis on various rolling stock types. As an example, the monitoring of doors and HVAC (Heat, Air Ventilation, and Cooling), with suppression of systematic maintenance, is now field-proven. Sensor data can help reducing the number and duration of rolling stock inspection.

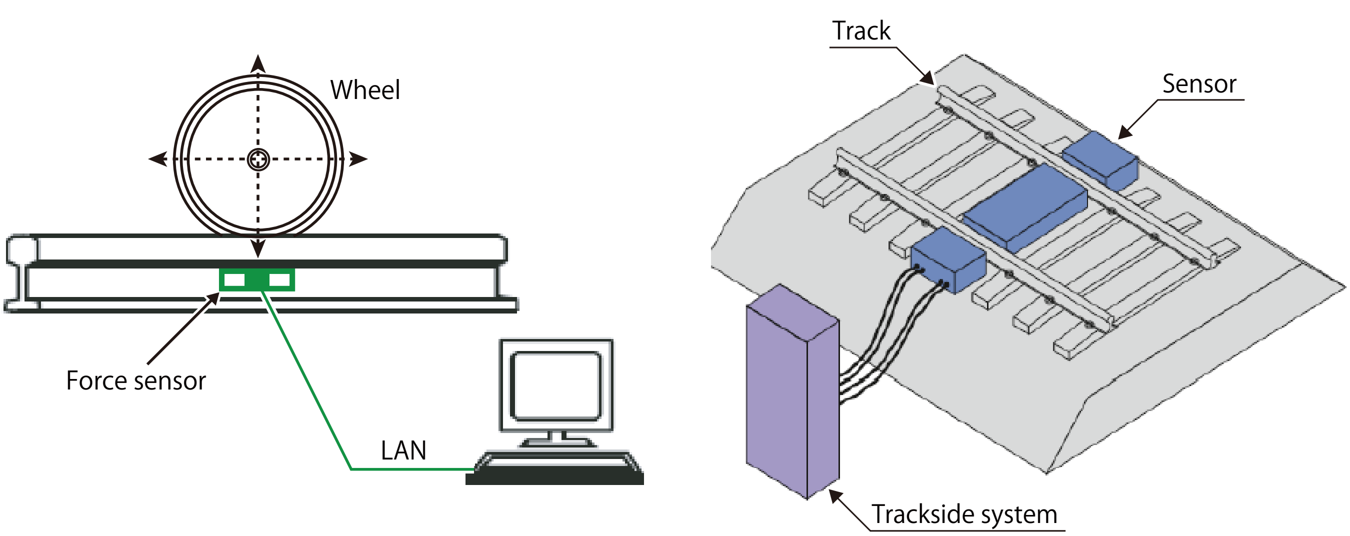
Additionally, the recent integration of few Way-side Train Monitoring Systems enabled gathering data concerning the rolling stock circulating on specific localisation of the railway network. Each time a train circulate through these systems, related forces and solicitation are gathered and stored in a dedicated database. The data gathered mainly concern the loadings, the speed and the balance of the weight (Left/Right and Front/Back) along each train.

A track monitoring system based on "light" sensors installed on commercial trains allows a daily continuous monitoring of track defaults and their evolution with short time-gap. Part of the post-processing is done on-board and the data are transmitted thanks to a 3G connection between the on-board system and a dedicated server. The multiplicity of data gives robustness, an adapted post-processing gives the benefit of the system.

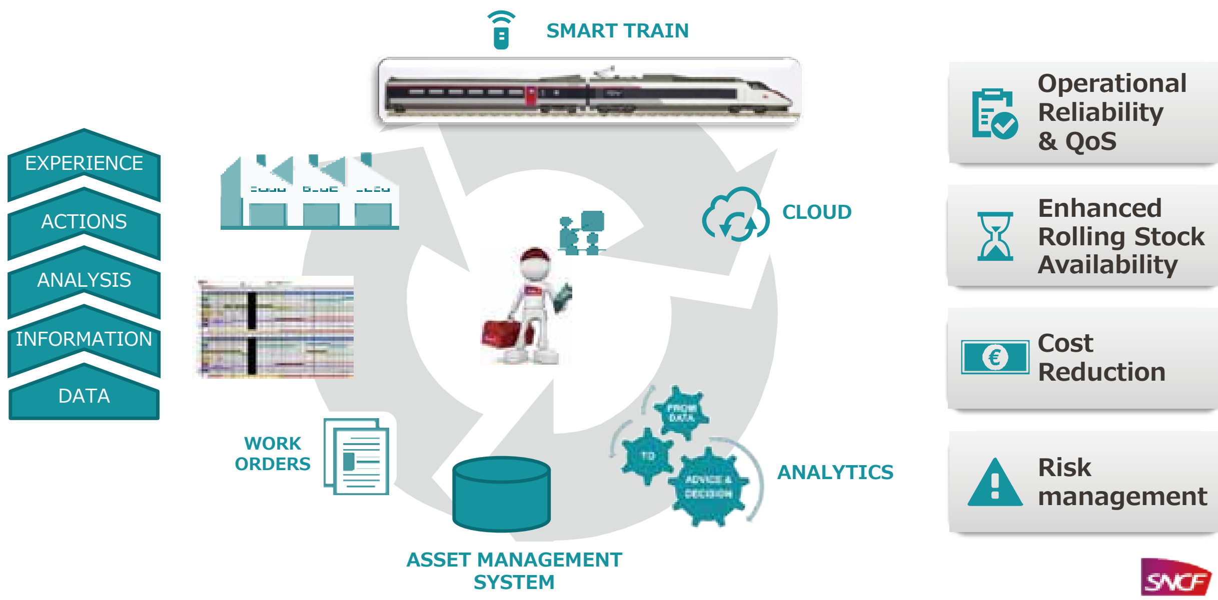
Our rolling stock automated diagnosis system prescribes the most probable troubleshooting tasks, and for newer rolling stock an automated validation of maintenance status replaces manual work. This automated test is also launched after repair, in order to check the system's status.

We are currently moving from digital maintenance to digital operations: Rolling stock fleet status is already deployed and running in some of our fleet supervision centres. For the railway network, four supervision centres manage the alarm received from sensors installed on more than 3000 km of line.

Standard consumer products as smartphones and tablets also play a major role in the digitalization of the maintenance. 90,000 employees of the company use them in their daily tasks. Thus the maintenance staff has a quick access to digitalized maintenance documents, has a direct connexion with the components manufacturers or internal experts hotlines and can make real time records. Of course the customers are also connected and this is an additional opportunity. An App has been developed to allow the customers to send an alert in case of stations equipment failure thanks to a QR code flashing. This allows the teams in charge of the station equipment maintenance to get



Schematic representation of WTMS systems



A vision for the future, starting yesterday

the information quickly and carry out the necessary repair.

Train depots are now organized as Factories of the future. Drones are used to inspect the top of the trains, technicians have real time assistance from experts thanks to glasses with augmented reality and cameras, 3D printing is used produce locally spare parts that are delivered to the technicians with autonomous vehicles.

One of the most recent projects developed at SNCF is Lidar. Thanks to sensors placed on the network monitoring trains, this technology allows to scan and map in 3D all the elements of the infrastructures (rails, catenary poles, signalling, structures, vegetation ...) with few millimetres accuracy. In one hour, Lidar is able to read on 50 kilometres of track when it takes normally six weeks. The tool improves agent's safety as it reduces their needs to go on the tracks. Thus, Lidar contributes to the traffic robustness and industrial maintenance performance.

Vibrato is part of the innovation that we developed at SNCF regarding infrastructures. This application uses the accelerometers and gyroscopes embedded on the driver tablets for real-time monitoring of vibrations occurring online in order to trigger earliest targeted maintenance works as soon as possible. Vibrato sends a geolocated file in real time towards a processing and operating platform. The data are then combined with those of the other trains. If an abnormal vibration is confirmed, a team is sent to inspect the track.

Digitalization is by no means an end itself and expertise still sits at the core of the solutions. Deploying digital solutions in an old industry like Railway transportation requires then several major changes in the management. First a lot of new skills are required, then an adapted recruitment program must be launched and appropriate training must be implemented for existing employees. The shift from standard preventive maintenance to predictive maintenance is a culture change that must be managed from the top to the bottom of the organization. Finally, the various solutions will have to be designed with the experts and end users so that they will be consider as a positive change.

Conclusion

The contributions of recent digital technologies developments to the field of maintenance are numerous and allow optimizing all aspects, from the detection of failures, to the achievement of maintenance. They even make it possible to act proactively over the product life cycle. The technology itself will not make those improvements and will only be an enabler. As for all the major changes that transformed the industry in the past decades, human will be a major factor to consider for a company that launches the digital transformation of its activity. This is of course true for the railway maintenance.

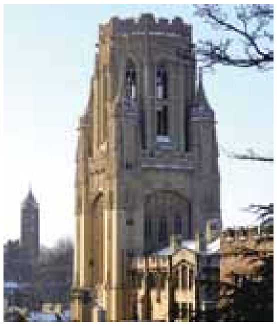
Japan's Contribution to ISO/TC 269

International standardization efforts for the railway industry started many years back, involving the International Electrotechnical Commission's Technical Committee 9 (IEC/TC 9) dealing with electrical equipment and systems for railways. Efforts in technical areas other than the electrotechnical and electronic products and services which are covered by IEC/TC 9, started in earnest in 2012 when the International Organization of Standardization established Technical Committee 269 (ISO/TC 269) Railway Applications. In 2016, three sub-committees were created under TC 269 to deal with infrastructure, rolling stock, and operations and services, respectively, further expanding the scope of deliberations for standardization.

Japan currently provides the chairperson for TC 269, the secretariat for the sub-committee on operations and services, and the convenor in six of the 13 working groups in charge of standardization development, thus playing a leading role in, and making great contribution to, the success of TC 269, its sub-committees, and related standards deliberations. The Railway International Standards Center of RTRI is a deliberation body in Japan for technical committees and sub-committees.

Mr. Kiyotaka Seki
General Director
Railway International Standards Center

During the six years that have passed since TC 269 was created, a significant number of standards and related results have been published following deliberations. One of these publications is a technical report, ISO/TR 21245, *Rail Project Planning Process*. For any rail project to succeed, it is essential to fully identify and consider a range of factors in the planning stage before selecting appropriate technologies and methods. ISO/TR 21245 should help even a first-timer on rail projects to clearly present the project's needs so that plans that reflect those needs can be developed in an efficient manner. Utilizing this process offers a variety of benefits. Plans can be developed in less time and at lower costs, while risks can be minimized. ISO/TR 21245 was developed following a proposal to that effect by Japan, which also played a leading role in its deliberations, contributing to the growth of the railway industry around the world. Hopefully, ISO/TR 21245 will continue to be utilized in the planning stage of various types of railway projects worldwide.

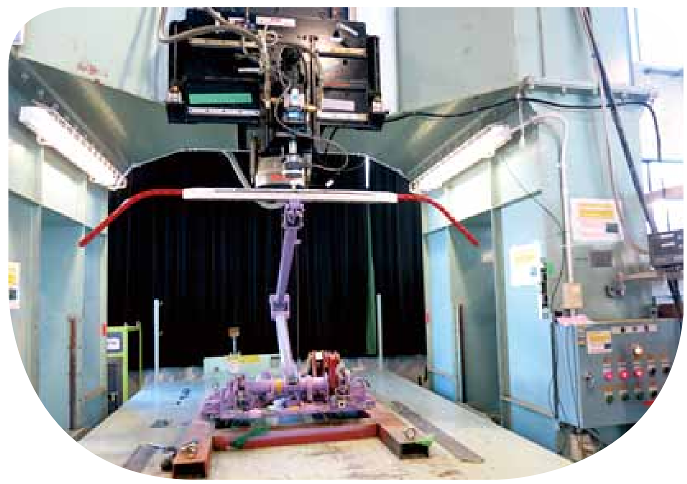


The university of Bristol

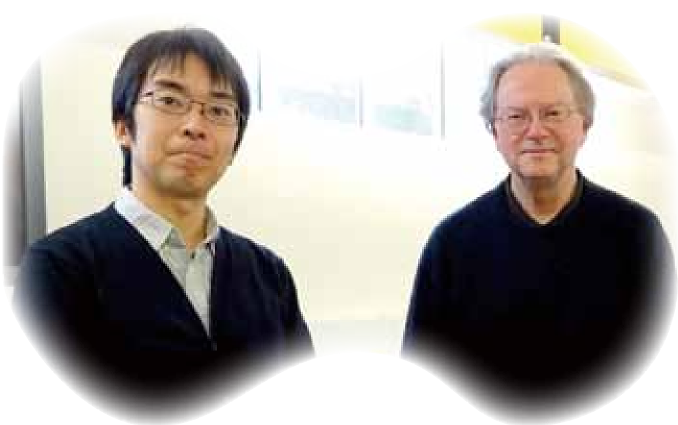
Collaborative Research with ACTLab on Pantograph/Catenary Hybrid Simulation

RTRI and Professor David Stoten, head of ACTLab (Advanced Control and Test Laboratory), University of Bristol, UK, conducted collaborative research from April 2016 to March 2018. Bristol is located in south west England and it takes 2 hours from London by the Great Western Railway, originally built by Isambard Kingdom Brunel in 1833. Historically, Bristol is well-known as a trade port and has extensive aerospace, advanced materials, electronic and automotive industries.

In order to evaluate the dynamic interaction of pantograph/catenary systems, RTRI and ACTLab have developed a hybrid simulation that is based upon a physical pantograph and a numerical simulation of the catenary. The hybrid simulation consists of the physical pantograph, a hyWaulic actuator and a real-time simulator. Measured contact forces between the pantograph head and the actuator are used to calculate the motion of the dynamical catenary model, which is constructed in the real-time simulator. In turn, the calculated displacement of the contact wire is used to generate the actuator control signal. Since the dynamic motion of the virtually travelling pantograph can be obtained from the bench test, the hybrid simulation can enable a rapid development of the pantograph. This collaborative research also developed a more stable hybrid simulation for pantograph/catenary, compared with the conventional 'HiLS' technique, by using the dynamically substructured system approach.



Pantograph test rig at the RTRI



Dr. Kobayashi Prof. Stoten

The investigators in the ACTLab

The proposed method was validated using a pantograph test rig at the RTRI, where the commonly-used pantograph of high-speed railways in Japan was virtually travelling under the catenary at 300 km/h. The measured displacement of the pantograph head corresponds very closely with that of an accurate simulation.

Our future work will be focused upon further validation of the proposed hybrid simulation method, based upon comparisons with measured data from actual on-track testing.

(**Shigeyuki Kobayashi,** Current Collection)

Current Status of the 12th World Congress on Railway Research (WCRR 2019)

RTRI will host the 12th World Congress on Railway Research (WCRR 2019) that will take place in Tokyo, Japan, from October 28 to November 1, 2019, and will be held at the Tokyo International Forum, a multi-purpose exhibition center. The theme of this congress is *Railway Research to Enhance the Customer Experience*, as previously reported in *ASCENT No. 4*. This is the world's largest international congress on railway research, proudly unprecedented in the sense that railway researchers and engineers gather together with managers and executives of railway operators in one congress.

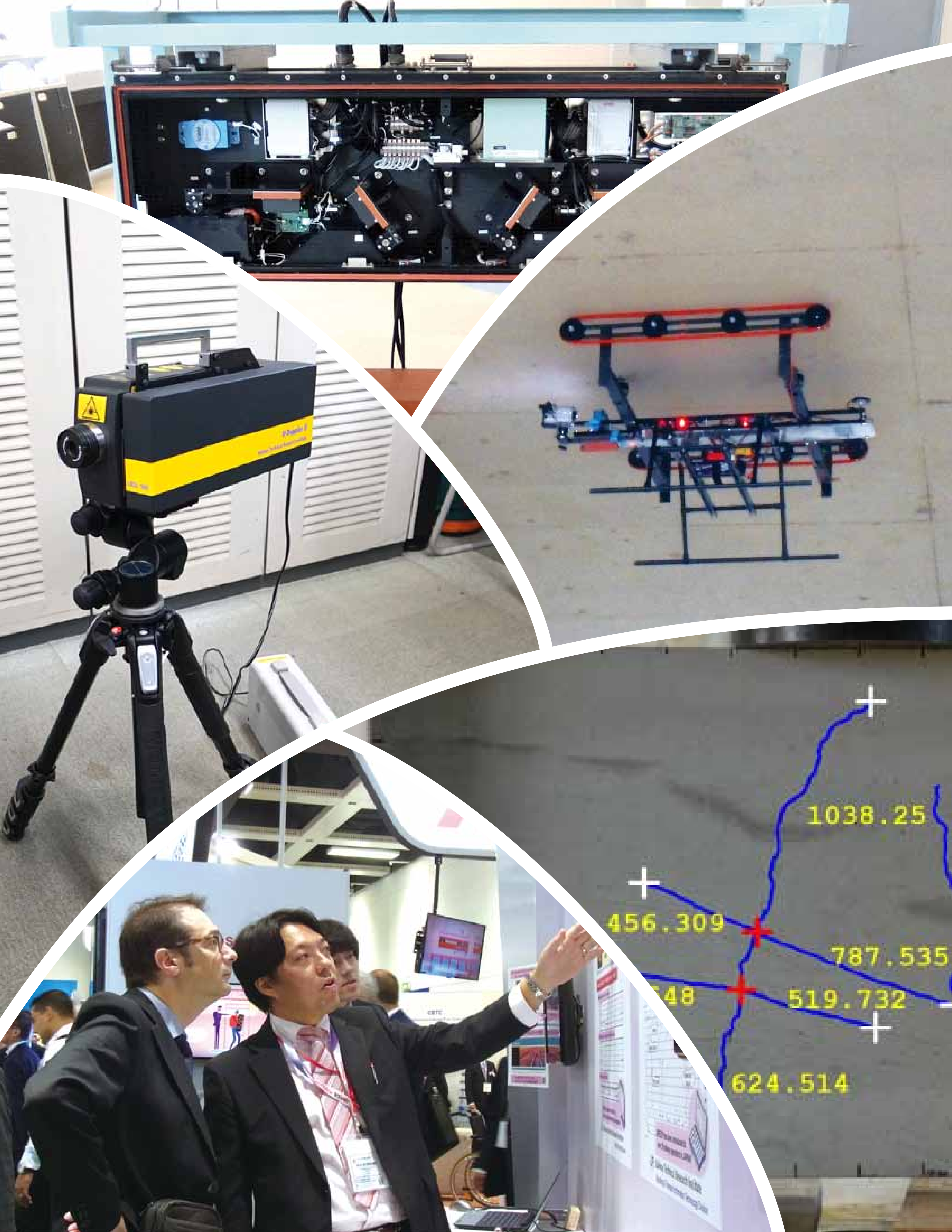
Currently, the secretariat of WCRR2019 is reviewing the abstracts that have been posted in order to identify those papers that will likely best express the world's development of railway technologies and accurately discuss future directions to be taken by railway operators. Approximately 350 papers will be presented in WCRR2019.

Various social events are being planned in conjunction with the congress, including a Tokyo Bay cruise on Tuesday night, October 29, and a gala dinner at TOKYO KAIKAN on Wednesday night, October 30. Exhibitions and advertisements from over 50 companies and institutions will be featured in booths throughout the WCRR2019. Several technical visits, including various guided tours, will be conducted to major sites in Japan related to railway research and development, including RTRI on Friday, November 1.

In the autumn of 2019, when we host WCRR2019, the Rugby World Cup will also come to Japan and will be followed the next year, in 2020, by the Tokyo Olympic Games. As a result, I firmly believe that visitors attending the congress will be able to experience a highly-charged, vibrant metropolis of Tokyo.

http://wcrr2019.org
For questions about abstracts/papers, please contact:
wcrr2019-paper@issjp.com
For other general questions about WCRR, please contact:
wcrr2019@issjp.com

(**Tetsuo Uzuka,** General Manager of WCRR 2019 Headquarters)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