News Release

Digitalization Technology Innovation Project Started

On April 1, the Railway Technical Research Institute set up the "Digitalization Technology Innovation Project."

1. Purpose of setting up the project

The new master plan of RTRI, RESEARCH 2025, has listed "Innovation of railway systems by digitalizing technologies" as one of its basic policies. In order to proceed with the research and development for this purpose quickly and in a cross-cutting way, RTRI set up and started the "Digitalization Technology Innovation Project". Under this project, all the research staff will work together to promote digitalization of railway systems by conducting basic research into image analysis and artificial intelligence and obtaining the research and development outcomes with the latest digitalization technologies as quickly as possible.

2. Research activities under this project

(1) To propose measures to innovate railway operation using digitalization technologies
   Identifying new technical challenges that will contribute to innovating railway systems using state-of-the-art digitalization technologies.

(2) Research and development to address new technical challenges
   Promoting research and development on the above-mentioned technical challenges and basic research into artificial intelligence and image analysis by using state-of-the-art digitalization technologies.

(3) Integrated and cross-cutting research and development
   Conducting cross-cutting research and development through coordinating different fields and topics that share the same digital techniques.

(4) Development of the know-how and resources for research
   Identifying sharable technologies, promoting cross-cutting use of them and providing researchers training programs

The following figure shows specific research topics regarding digitalization that RTRI has been addressing. In the fiscal year 2020, 40 research projects will be started, aiming to introduce image analysis, artificial intelligence, telecommunications and networking technologies to railway operations.
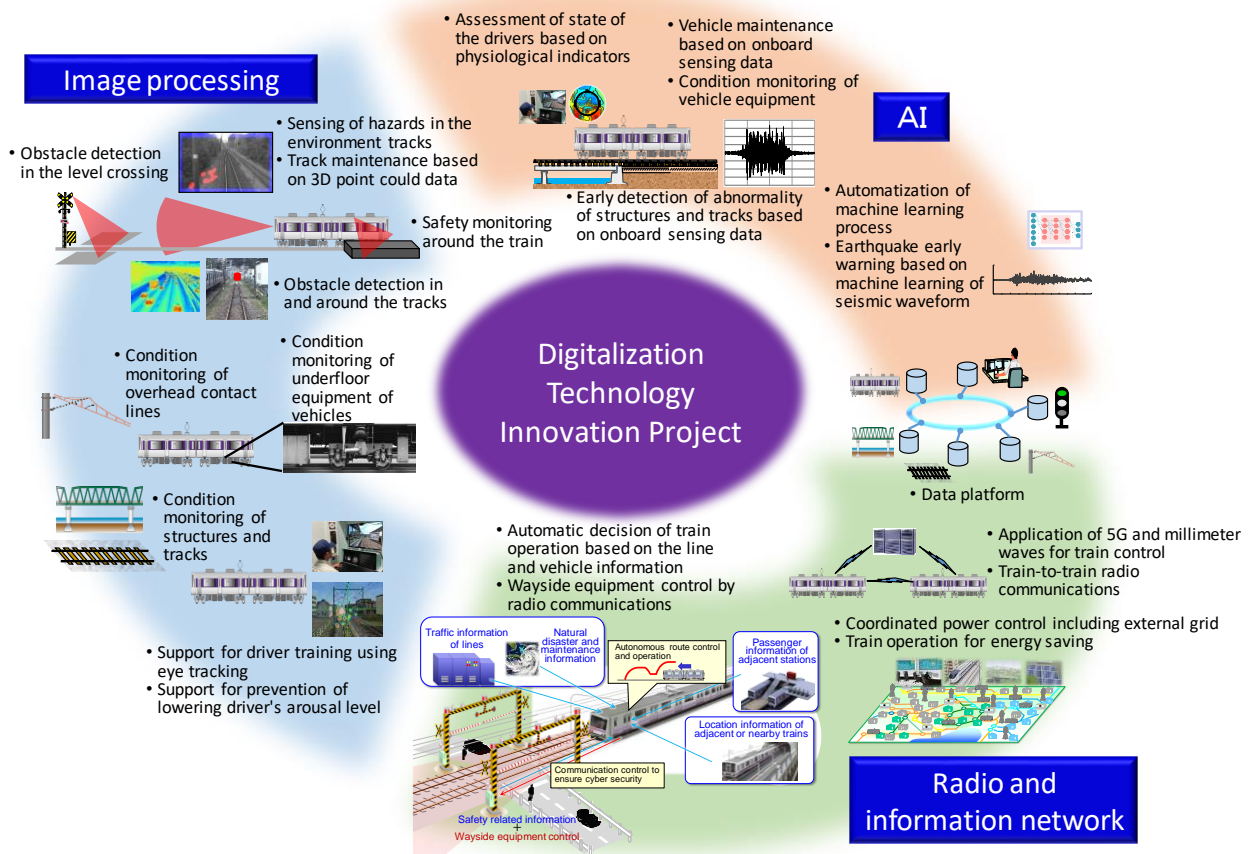
【**Image analysis**】

We will develop techniques using image analysis technologies to detect obstacles lying 600 meters ahead of a train and to visualize objects that are difficult to recognize by human eyes and seek to apply them to railway operation in order to improve the safety and innovate maintenance of railways.

Specifically we will develop a system to detect on-the-track obstacles by analyzing images ahead of and around the train, a system to support visual monitoring of the track and condition-based monitoring systems for vehicles, structures, and tracks.

【**Artificial intelligence**】

We will develop methods to automatically extract machine learning data which is useful for detecting troubles of railway facilities and a method to trace train control and decision making. We will seek to apply the outcomes to develop automated detection, prediction and decision making on drivers and facilities conditions.

Our research and development includes a method to detect troubles of tracks and facilities early and to estimate vehicle equipment conditions using the digital data measured on board, and a method to estimate conditions of train drivers based on physiological indicators. In addition, basic technologies including a method of early earthquake warnings using machine learning data of seismic waveforms will be developed.

【Telecommunications and networking】

We will address research to apply 5G mobile communication systems and millimeter waves to safety related control. This technology is expected to support autonomous train operation which will be more resilient, with less ground equipment.

We will develop autonomous train operation systems that control the trackside equipment during train running based on digital information on track and trackside conditions, disaster prevention and maintenance and passenger flow. We will also develop energy-conserving technologies such as coordinated power control. We will also develop a data platform that will provide us a shared base for cross-sectional commitment.

Some examples of the 40 research topics are as follows.

Autonomous train control method

We will build an autonomous train control system. In this system, running trains directly control the trackside equipment such as turnout point machines and level crossings and autonomously set the routes and speed profiles. With this system, ground equipment will be reduced and driverless train operation will be achieved.

Early trouble detection method for track and facilities with on-board digital sensing data

This method will be able to detect early troubles and failures of tracks and facilities including track subsidence and bridge pier subsidence and slant only with on-board sensing data. This technology will prevent train running disruptions and accidents and enable more efficient maintenance by planned repair and reinforcement.

Improved trouble detection method for overhead line fittings

Using the images obtained by on-board line cameras, this method will detect troubles of the fittings such as pull-off arms and crossing bars at crossovers by the information of their shapes and colors. This will save labor in the overhead line maintenance and achieve more efficient facility maintenance.

Early earthquake detection method with machine learning of big data

We will propose a method to apply machine learning data to train operation in real time in order to raise performance of early earthquake warnings. Using a massive amount of waveform data measured by seismometers, this machine learning will make it possible to distinguish between noises caused by earthquake shakings and train vibrations and to estimate earthquake elements.

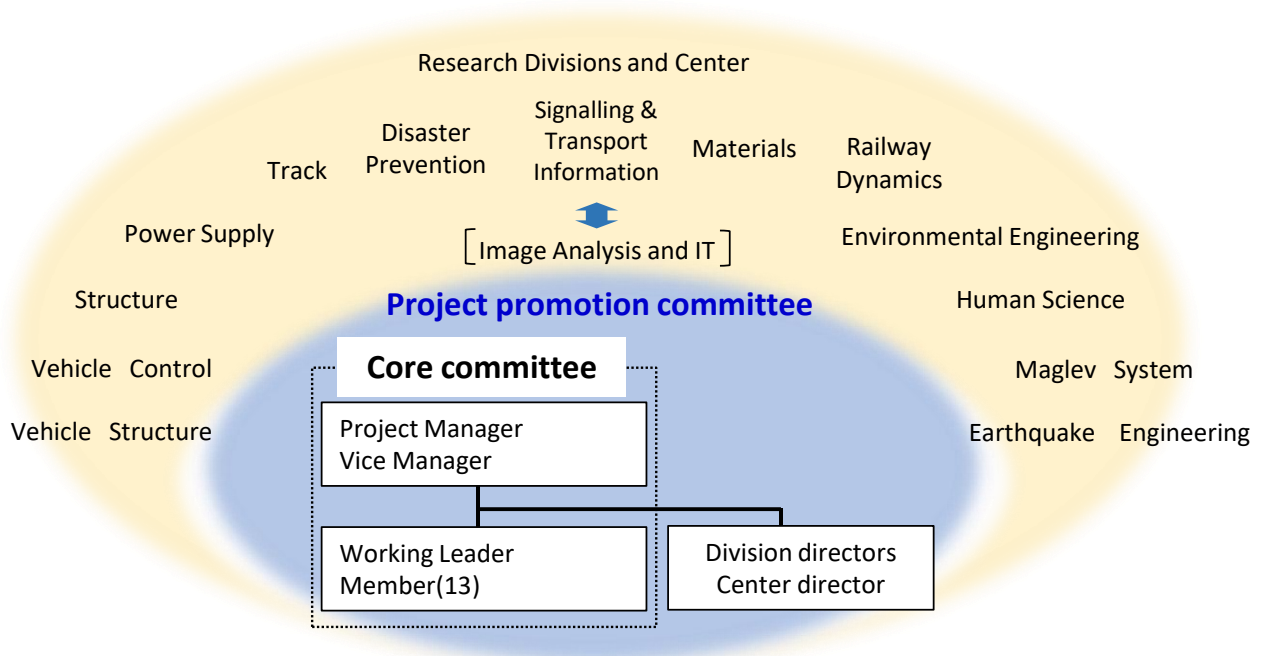### Automation of the machine learning process in trouble detection

We will aim to apply to commercial train operation a system to detect troubles by applying machine learning to vibration data of vehicle equipment. For this purpose, we will develop a method to

automatically extract machine learning data, for example, to remove abnormal data from among normal data.

We will conduct research and development of the above-mentioned technologies by utilizing basic technologies such as image analysis, artificial intelligence, telecommunications and networking in a cross-sectional manner and coordinating related research projects. Based on the outcomes, we will support railway operators in applying digitalization technologies to railway operations.

3. Organization of the project

The project promotion committee including the core committee will determine the research policies and, based on the policy, each of the research divisions and centers will conduct the research. The Image Analysis and IT Laboratory that was set up in the Signaling and Transport Information Technology Division in 2017 will be the core for utilizing digitalization technologies and developing the research staff.

Research Divisions and Center

Disaster Prevention | Signalling & Transport Information | Materials | Railway Dynamics

Track

Power Supply

[Image Analysis and IT]

Environmental Engineering

Project promotion committee

Structure

Human Science

Vehicle   Control

Core committee

Maglev   System

Vehicle   Structure

Project Manager
Vice Manager

Earthquake   Engineering

Working Leader
Member(13)

Division directors
Center director

The members of the core committee are as follows:

Project Manager : Dr. Norimichi Kumagai, President

Vice Project Manager : Dr. Ikuo Watanabe, Executive Vice President responsible for the entire research and development

Dr. Shunichi Kubo, Executive Director responsible for the Research and Development Promotion Division

Working Leader : Mr. Shigeto Hiraguri, Deputy General Director, Research and Development Promotion Division

Members: 5 division directors, 5 laboratory heads and 3 senior researchers

4. Discussions at the first meeting

The Digitalization Technology Innovation Project was set up on April 1 this year and its first meeting was held online on April 28, with a limited number of 10 attendants (Photos 1 and 2).

The meeting was started by President Kumagai's opening note and followed by discussions on the basic policies and the work schedule for this project. The issues discussed there included specific research targets including application of digitalizing technologies to maintenance, coordinated control of power supply network and trouble detection by data. They also discussed the importance of coordinated research among different fields through sharing algorithms, sharing expertise and outcomes, and collaboration with other organizations including overseas ones in order to introduce state-of-the-art technology speedily. In addition, it was proposed that we should conduct on-line research into the latest technologies under this restriction of all the activities due to COVID-19. President Kumagai concluded that sharing and integrating information among different research fields are the key of this project.

【**Keynote Message by President Kumagai**】

We will be utilizing digitalization technologies quickly in train operation and solving the issues of safety, maintenance, energy and cost. In order to do so efficiently, the role of this project is to share information and show guidelines through integrating relating research topics and projects. The core members and responsible researchers must cooperate and promote this work together. As our research collaboration partner SNCF also has a strong interest in the railway application of digitalization technologies, I would like to proceed with the research together, inspiring each other. I would like to ask for your cooperation and expect all of you to do vigorous research activities.

【**Comment by Executive Vice President Watanabe**】

In this age of rapid technological advancement, it is important to proceed with this project swiftly. As railway operators have high expectations for the introduction of digitalization technologies, we would like to extensively mobilize our resources covering a variety of technical fields in order to pursue this project.

Online meeting with President Kumagai(right) and committee members